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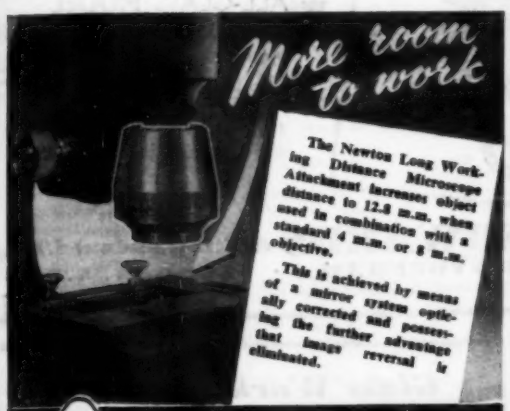
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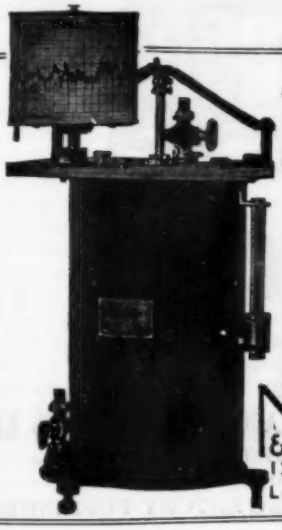

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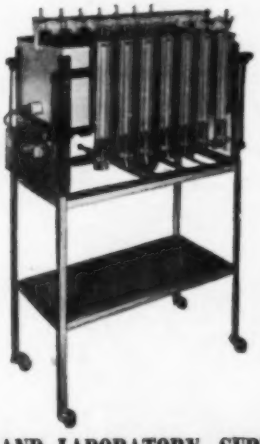

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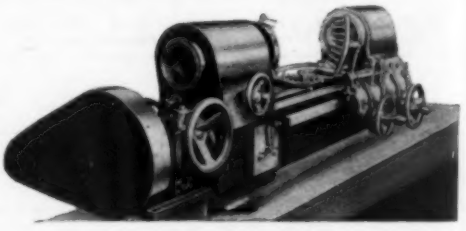

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MAN-POWER AND PRODUCTIVITY

SINCE the critical importance of higher technological education in relation to industrial productivity was discussed by Section L (Education) at the British Association meeting in Birmingham last September, the general trend of current affairs in Britain has emphasized the vital importance of productivity and efficiency in the use of man-power and materials over the whole range of our economy. More than ever, national security and the standard of living we can maintain in our homes depend upon the success we can achieve in eliminating waste in every form and using our resources to the most productive effect. The announcement of the Minister of Supply on December 28 restricting the use of zinc, brass, copper and copper alloys in household appliances and for some other purposes should bring home to all the need for economy in the use of material resources. On the man-power side, it may be noted that, speaking at Brighton in December to the London and Home Counties Regional Advisory Council for Higher Technological Education on productivity and higher technical education, Sir Ewart Smith urged that our target should be a ten per cent increase in productivity for the next ten years, and thereafter five per cent.

Realization of this increasing stringency of man-power may well have contributed to the comparative acerbity which characterized the discussion at the annual Conference of Universities of Great Britain and Northern Ireland held in London on December 16 on students and national service. That discussion, moreover, bears very closely on the proposal for a sample call-up of Class *Z* reservists to the Army and Air Force which the Government is understood to be considering. In defence, as elsewhere, the efficient use of man-power is a cardinal consideration; and, apart from any military value which the scheme may have, it is a first essential that there shall be no waste of the men's time. The university student may present an extreme case; but whether he does his national service before or after his university training, the principle stated by Sir Geoffrey Ince, that man-power should be used efficiently, is the right one, and it should be universally applied in national service training and in any sample call-up. There is ample scope in a modern army for intellectual ability.

What would appear to be one of the outstanding impressions given at the Universities Conference by the discussion on national service as it affects students is the frequent failure of national service to elicit response from those conscripted in peace-time. The evidence of demoralizing boredom presented to the Conference may not be entirely the fault of military administration; it may be due in part to a wrong and selfish attitude of many young men towards national service, which sometimes their parents and others encourage. But, whatever the cause, it indicates exactly the same lack of understanding and co-operation upon which efficiency depends, both in the Services or in industrial life.

That point was well made at the conference of the Institute of Personnel Management on problems of man-power and industrial relations, held at Harrogate last October, and it recurred in a discussion on productivity at a meeting of the Parliamentary and Scientific Committee on November 7. This discussion, a summary of which has now been published*, was initiated by Sir Geoffrey Heyworth, Sir Thomas Hutton, general manager of the Anglo-American Council on Productivity, Mr. Lincoln Evans and Sir Charles Colston. Sir Geoffrey Heyworth based his remarks on a speech made to the annual meeting of Lever Bros. and Unilever, Ltd. (cf. *Nature*, **166**, 1097; 1950), and he emphasized particularly that, for success in productivity studies, the complete understanding of objectives by both workers and management is essential. Attempts to get results quickly, without waiting for that understanding and allowing time for training the additional personnel to make the studies and to co-operate with management and workers in getting full appreciation of their application, are liable to defeat themselves. When the pressure for extra productivity is so intense it is vital to guard against this danger.

Mr. Lincoln Evans, general secretary of the Iron and Steel Trades Confederation, equally stressed this point of co-operation and the need for taking the worker into the complete confidence of the management, explaining not only the methods to be adopted but also the purpose to be achieved. He recognized that it will be a big task to break down the suspicion on the part of the workers that when scientific methods of wage measurement are adopted and result in increased output and increased earnings, someone will suggest that wages are too high and that the rate should be cut. He thought, however, that there is real evidence of a change in the thinking of trade unionists, though by its nature it must be a slow process. Sir Thomas Hutton's account of the work of the Anglo-American Council on Productivity stressed this same objective of encouraging a livelier interest by trade unions and by operatives in production problems, and a greater willingness to try out new methods and abandon outworn ideas. Such an objective is an essential part of the wider one of promoting greater productivity-consciousness in all ranks of industry and greater co-operation in pursuing it.

This educational aspect of the Council's work may well prove to be more fundamental and far-reaching than the actual introduction of new methods or new machines by individual firms; and it is one which requires increasing co-operation from the professional associations. Scientific workers have been among the members of a number of productivity teams and, as Sir George Schuster said in the discussion, productivity still offers much room for scientific investigation. The whole question of time- and motion-study has yet to be put on a proper scientific basis, and this is a preliminary step towards securing the confidence of the workers. All kinds of factors that affect people's attitude to work require study, and Sir George Schuster once more emphasized that such research will never be properly directed or fruitful unless it is carried on with the active interest and co-operation of the people who are concerned with the practical conduct of industry.

Except possibly in Sir Charles Colston's observations on incentives and the group system, nothing in this discussion indicated appreciation of the outstanding lesson of Elton Mayo's famous Hawthorn Experiment with the Western Electric Company, that without social satisfaction full efficiency and productivity cannot be achieved. Here indeed is need for fundamental thinking, as well as for educational work, and a chapter, "Industrial Disenchantment", in Sir Harold Butler's recent book, "Confident Morning" (London: Faber and Faber), could be studied with profit by all concerned with this question of productivity. "Industrial relations have not been radically improved by the extension of collective bargaining, by the establishment of joint industrial councils, or by nationalization. None of these expedients has produced that whole-hearted co-operation between management and workers, upon which high productivity depends, and which was so confidently predicted for industries under public ownership."

Sir Harold Butler shows clearly how complex is the whole question of industrial relations, and that, so far from solving the problem of co-operation, nationalization has raised fresh issues that have not yet been fairly faced. He directs attention to the antinomy between planning and the traditional liberties of workers and trade unions, as well as to the wider and more general dangers to freedom that concentration of power in the hands of the State involves. It is not merely the question whether industry can run effectively under elaborate bureaucratic control, but equally whether the free activities for which the trade unions have contended from their formation are compatible with a nationalized economy.

This is a matter to which professional associations also will have to give increasing attention in future, and a constructive and positive approach will be required. Realization of the dangers of the situation, as indicated in Prof. J. W. Cook's presidential address to the Royal Institute of Chemistry last March, should be but the first step to that end. It may well help in clarifying ideas about the functions of the trade union in a nationalized economy and under conditions of what is termed 'full employment'. Indeed, it should be recognized that some professional bodies, like the Institute of Personnel Management, are already attempting to bring fresh, objective and constructive thought to bear on such problems.

Mr. L. P. Scott's examination, at the Harrogate conference of the Institute, of the extent to which co-operation between management and men in industry is desirable, is an example that is highly pertinent to the current discussion of productivity. While he believes there is a valuable field for co-operation in security and communications, he thinks also that no form of joint working can ever overcome the divergence between producer and consumer, between man-

* Parliamentary and Scientific Committee. Productivity: Summary of a Discussion at a Meeting of the Committee at the House of Commons, 7 November 1950. Pp. 24. (London: Parliamentary and Scientific Committee, 31 Palace Street, S.W.1, 1950.) 1*s.* 3*d.*

agement and workers: in short, that the attempt to associate trade unions with management is mistaken. If by frank disclosure of information and encouraging a sense of participation in the work of the firm, management could destroy the men's traditional attitude to productivity and replace it by confidence in the fairness, honesty and decency of management, productivity is more likely to be promoted than by a direct attack through joint collaboration.

The clash between individualism and totalitarianism inherent in the present situation cannot be disregarded. It may well frustrate efforts to increase productivity, like the attitude discussed by Mr. Scott, unless, side by side with the scientific study of productivity and the educational work being attempted by the Anglo-American Productivity Council, to which the Parliamentary and Scientific Committee, in arranging this discussion and publishing so promptly this summary, has now lent its powerful support, there is an attempt by both sides to think out a new industrial philosophy in the light of the failures of the past thirty years. Over that period there has been, as Mr. G. M. Young recently observed, a revolution in our thought about the State. It is apparent in our attitude to such matters as the direction of labour, State control, and delegated legislation.

These are issues that touch everyone, scientific and professional men not less than their fellows. They must think out afresh the functions of their professional institutions in the new age, and the conditions under which their specialized service can be most freely and effectively given. One of the merits of this problem of productivity is that it makes plain how wide the area of co-operation and discussion must be. It offers indeed an outstanding opportunity for engaging the interest and providing a field of useful and productive work for those best qualified to participate, and promises to widen the area of well-informed discussion which such factors as party organization, the vast size of a modern electorate and the technical intricacies of modern administration tend to contract.

THEORY OF ATOMIC COLLISIONS

The Theory of Atomic Collisions

By N. F. Mott and H. S. W. Massey. (International Series of Monographs on Physics.) Second edition. Pp. xv+388. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 35*s*. net.

THE first edition of Mott and Massey's book published in 1933 has become a classic. One evidence for this is that no other book on this subject has appeared. The new edition fulfils the high expectations of the users of the old. It has grown by about one-third in size, and the authors must be congratulated on the wise choice of the added material, as well as on their restraint in not letting the volume grow any more in spite of the large amount of new material available.

With the direction that physics has been taking during the last seventeen years, it was obvious that the main emphasis in the new material had to be on the extension of the theory to relativistic energies and on its application to nuclear collisions. A whole new chapter on nuclear collision phenomena has been added. In this chapter the emphasis is properly on the *collision* aspect, as distinguished from a detailed discussion of the problems of nuclear forces. However, many of the interesting experimental results on the spacing and the width of resonance-levels formed in neutron as well as proton scattering are listed. Sample experimental curves on resonances are given. Emphasis is laid on the theory of the compound nucleus, on scattering of neutrons by molecules and on magnetic scattering of neutrons.

An especially good feature of the new edition is that the theoretical methods applicable to nuclear collisions are presented, together with the general theory of atomic collisions. Thus in Chapter 8, which treats the general theory of atomic collisions, the "method of the collision complex" (compound nucleus) is discussed in detail and its range of applicability compared with that of other methods. Chapter 8 has generally been improved and clarified. Similarly, in Chapter 2, explicit calculations of the scattering by various special potentials have been added with a view to the application to nuclear phenomena; a discussion of the dispersion formula for the one-body problem is included. In the chapter on Coulomb scattering, the important radial Coulomb wave functions are discussed in more detail, and the penetrability of the potential barrier has been added.

Next to nuclear effects, the relativistic effects have received most of the additional space. Thus in Chapter 4 the relativistic scattering by a centre of force has been expanded and comparison with experiment included. It is gratifying to see that the effect of spin polarization on the double scattering, first predicted by Mott, now agrees with experiment. Adequate discussions are given of the properties of positrons, such as pair production and the differences in the scattering of positrons and electrons.

In the more 'classical' parts of the theory, some sections have been shortened. For example, nobody will much regret the omission of the chapter on the collision of electrons with molecules. Some sections have been much improved, such as the one on exchange effects in scattering of slow electrons, where now agreement with experiment has been achieved, at least for helium. The theory of resonance effects on collisions between atoms has been made more quantitative and at the same time abbreviated. On the other hand, it seems remarkable that the section on the Ramsauer effect has remained unchanged, indicating that apparently no further work has been done on this important subject.

Some slight omissions may be recorded. There is only a very brief reference to 'shadow scattering' and none at all to its importance for nuclear scattering. The reference to the semi-empirical results on the stopping power of matter for fast particles is also extremely brief. The reader might expect a more thorough treatment of the influence of radiative forces on the scattering by a potential and of the importance of this problem in the recent development of quantum electrodynamics. Apart from these minor points, the selection of material is admirable, not only of that which is included, but also of the topics which are left out or treated briefly.

There is no doubt that this book, like its first edition, will be a necessity for students of quantum theory as well as for many experimental physicists.

HANS A. BETHE

SEVENTEENTH-CENTURY VISITORS TO INDIA

Indian Travels of Thevenot and Careri

Being the Third Part of the Travels of M. de Thevenot into the Levant and the Third Part of a Voyage round the World by Dr. John Francis Gemelli Careri. Edited by Surendranath Sen. (Indian Records Series.) Pp. lxiv+434+20 plates. (New Delhi: National Archives of India, 1949.) 20 rupees.

THIS volume forms one of the Indian Records Series; it differs, however, from its predecessors in that it is not strictly a 'record' of India but is the impression of two foreign visitors. Many travellers, merchants and diplomats visited India in the seventeenth century, and the editor has selected two of their accounts for publication in this Series. Jean de Thevenot was in the country during 1666–67, as a young man aged thirty-three; Giovanni Francesco Gemelli Careri reached India in 1695, when he was forty-four. Their accounts were translated into English in 1687 and 1704, respectively, and these translations are now reprinted and edited by Dr. Surendranath Sen, director of the National Archives of India.

It can be said at once that this edition owes almost everything to Dr. Sen. He has contributed a most interesting and valuable introduction which draws on all the foreigners who visited the country during the century, and makes useful comparisons between their records. Dr. Sen has also added a vast appendix of notes, itineraries, bibliography and index, and it is probably true to say that little more could be added to what he has written. On these grounds Dr. Sen deserves both congratulations and thanks.

Explaining the general ignorance of the geography of India in the seventeenth century, Dr. Sen remarks of the travellers generally: "they did not know the country as a whole and in most cases their stay was all too brief". This is a fair comment on both Thevenot and Careri. The first arrived at Surat in January 1666 and returned there in the following December. In a little more than eleven months, he travelled over a strip of country across the peninsula from Ahmedabad "built in a lovely plain" to the "excellent" coast of Coromandel, whence came ships of all nations. Thevenot himself saw there "Cochin Chinese, Men of Siam, Pegu, and of many other Kingdoms of the east". This was a very small part of India, and yet Thevenot writes about many other districts as if he knew them, and in consequence falls into error. Similarly, Careri reached Daman in January 1695 and sailed from Goa in the following May. Except for one short journey inland from Goa to Galgali, on the Kistna river, "where the Moguls' camp was", his route was down the west coast. This one encounter with the army of Aurangzeb gives him a chance to write of the Mogul Empire, and elsewhere he deals briefly with such matters as "the climate, fruit, flowers, minerals, beasts, and coin" of Indostan.

The errors of these travellers, which are corrected by Dr. Sen's notes, do not make their accounts worthless, and there is a wealth of material here of the greatest value—descriptions of ports, customs of the people, methods of travel, roads and natural resources, to name only a few. It is impossible to do justice to all this material in a short review. Further, where these travellers overlap they can be checked with each other. Thevenot gives almost correctly the latitude of Surat—Careri is a degree out; the "almost all ruinous" walls in 1666 were still "weak" thirty years later; and so on.

There are a great many printer's errors in this book, and a Government which has such a splendid service as the Survey of India might have produced two better maps to illustrate the scholarly work of its director of archives. J. N. L. Baker

MODERN DEVELOPMENTS IN PROTEIN CHEMISTRY

Advances in Protein Chemistry

Edited by M. L. Anson and John T. Edsall. Vol. 5. Pp. ix+481. (New York: Academic Press, Inc., 1949.) 7.50 dollars.

THIS volume opens with a fine review by J. S. Fruton, who surveys in a masterly manner the development of synthetic methods and presents tables of every peptide that has been prepared. Our knowledge of the enzymic synthesis, hydrolysis and transfer of peptide bonds is now entering an exciting stage, and it is indeed fortunate to be able to refer to such a review for the preparation of the peptides, upon which so much of this work hinges.

G. R. Tristram in his review on the amino-acid composition of purified proteins gives an able discussion of the existing methods of analysis, the useful interpretations that can be made from analytical results and the rules to be observed, not only for interpretations but also in the methods for presenting data. It is clear that, for most of the amino-acids, methods have reached a fairly reasonable standard of accuracy.

In the reviewer's opinion, too many nutritionists use a teleological method of expression. J. B. Allison is one of these; to quote an example (p. 169): "The breakdown of tissue to supply the methionine on a protein-free diet could be reflected by a high excretion of urinary body nitrogen". This sentence ignores the dynamic approach that would explain the nitrogen excretion on the basis of a drain on methionine produced by protein turnover and which would result in the accumulation of amino-acids due to the failure to resynthesize protein because of a methionine shortage. Allison's review does, however, contain a good discussion of the methods and problems of the biological evaluation of proteins.

T. L. McMeekin and B. D. Polis have made a useful collection of the published data on milk proteins. Plant proteins are reviewed by J. W. H. Lugg, chiefly from the point of view of the analyst. From a collection of what he believes to be the most reliable data, Lugg has made several phylogenetic generalizations based on the amount and variety of amino-acids found in the bulk proteins of different plant types. It must be remembered, however, that for the Pteridophytes, Bryophytes and Algæ they are based on the analyses of very few amino-acids. A more interesting speculation made in this article is that protein denaturation leads to the degradation and resynthesis of protein or, in other words, the protein cycle, and that this would account for a proportion of the respiration of the resting cell because this resynthesis can only be achieved by energy-requiring mechanisms.

H. P. Lundgren's review of synthetic fibres made from proteins is excellent. With his clear expression and simple models, everything has been made easy for the reader.

The survey by K. H. Gustavson of the protein chemical aspects of tanning processes gives the reader an interesting and exhaustive account of the present-day knowledge of how leather becomes what it is and what it has become.

Proteins, lipids and nucleic acids in cell structures and the known facts about their function and distribution are given in a very readable review by A. Claude. The template theory of protein reproduction has received its latest and well-directed blows from him.

This is a very good volume. The reader, however, has to cope with more than his just share of small errors.

THE UNICORN IN MUSLIM ART

The Unicorn

By Richard Ettinghausen. (Freer Gallery of Art. Occasional Papers, Vol. 1, No. 3: Studies in Muslim Iconography, 1. Smithsonian Publication 3993.) Pp. xii+209+48 plates. (Washington, D.C.: Smithsonian Institution, 1950.)

THE scope of this monograph is well defined by the title of the series of which it forms the first: all the author's researches into other fields—literature, travels and zoological writings—as also his excursuses into other cultures besides the Islamic, are brought to bear on his primary concern of analysing the iconographic manifestations of the unicorn motif in Muslim art. As he himself frequently emphasizes, the collection of the relevant material in all these many fields is still far from being sufficiently complete to permit an exhaustive treatment of the subject; nevertheless, Dr. R. Ettinghausen's monograph assembles with great erudition the essential part of such material as has to date been made available by the labours of himself and others. In this respect, and also by posing (and only partially answering) certain crucial questions, it may serve to indicate the necessary lines of research on the problem for the future.

The author's powers of exposition, as well as his critical faculties, are unfortunately not equal to his erudition. The work as a whole lacks clear conception, and unnecessary confusion is caused by scattering the treatment of various aspects of a single question in several places throughout the book; moreover, the deficiency extends to important matters of detail—to take only one example, it is, in several instances, virtually impossible to be sure whether the writer is using the term *karkadann* in the zoological sense of rhinoceros or the mythological sense of unicorn. A typical paragraph of somewhat confused argument, with a dogmatic and practically meaningless conclusion, will be found on p. 71.

Some parts of the work seem almost a parody of the proverbial 'Teutonic' combination of thoroughness and pointlessness; I would cite the table of confusions and corruptions on p. 43. The possibilities of error, vagueness and exuberant fantasy being limitless in a matter of this kind, it is difficult to see the value of submitting examples to statistical treatment. In this question of *karg* versus *gurg* there is a strong savour of the chicken versus egg controversy, but Dr. Ettinghausen might find it useful to take counsel on the vocalization of some of his rhymes as it might have sounded in the original tenth-eleventh century Persian; this would at least have more weight than what even Nöldeke "definitely states". Surely, at least one 'human' explanation of the misplacing of the rhinoceros's horn, even by those who had seen the animal, may be found in distracted alarm at his proximity, coupled with a natural failure to grasp the peculiar shape and set of his head? In criticizing the average Muslim writer's juxtaposition of contradictory facts (p. 148), the author is probably guilty of an all too common insensitiveness to the immense flexibility of the word 'and' in Arabic, and to the elliptical nature of the language generally.

In respect of typography, bibliography and illustration, the work is produced with a care and magnificence rarely seen in our day. Some half-dozen slips in English constitute only a very minor blemish. Probably the only scholars who will fail to find a large amount of valuable material in this book are zoologists (inevitably), mythologists and those expecting some treatment of the notional and symbolical aspects of the question.

G. M. WICKENS

THE BIOLOGICAL NATURE OF MAN

Man is a Microcosm

By J. A. V. Butler. Pp. xii+152+8 plates. (London: Macmillan and Co., Ltd., 1950.) 10*s*. 6*d*. net.

NOT every man of science is able to write a book which gives a clear and succinct summary, acceptable to the intelligent layman, of a wide field of recent work, most of which is not directly related to the author's own special studies. The writer of such a work has to steer his literary ship between the Scylla of popular pseudo-science and the Charybdis of uncompromising technicalities. In this book, the author has been completely successful in his methods of dealing with biochemistry, embryology and neurology in relation to man.

Dr. J. A. V. Butler has taken as his motto a *bon mot* of St. John Gogarty, "Stone walls do not a prison make, but scientific terms do"; and without neglecting the claims of clear scientific English, Dr. Butler has discussed the place of life in the universe, how it may have originated and what is known at present of proteins, enzymes, vitamins, viruses and genes. He has shown how the biological scientists of the past few decades have revealed something of the great complexity of the patterns into which the ultimate particles of the universe are woven in living things. When these facts are widely understood, "men may again feel that they are not out of keeping with the splendour of their setting". Thus the book is an attempt at a revaluation of man from the point of view of the biologist. As such, it is an antidote, or at any rate a complement to the ephemeral cosmologies, now in spate, with their partial and often perverse views of the nature of man and his place in the universe.

The illustrations and general production of the book are excellent and its price is reasonable. It can be recommended without reserve to a large group of readers. In particular, it should meet a need for sixth-form 'scientists', specialists in certain subjects who wish to enlarge their field of general study, and students and teachers of biology and medicine who require integrating factors in their studies of living and striving man.

W. L. SUMNER

The Statesman's Year-Book

Statistical and Historical Annual of the States of the World for the Year 1950. Edited by Dr. S. H. Steinberg. Eighty-seventh annual publication, revised after Official Returns. Pp. xxiv+1594. (London: Macmillan and Co., Ltd., 1950.) 36*s*. net.

THIS indispensable annual again makes its appearance, revised up to the spring of 1950. No other volume contains such an array of factual information—political, social and economic—about all the countries of the world. The long-familiar format and arrangement are maintained. About half the book is devoted to the British Commonwealth and the United States, and the remainder to the countries of the world in alphabetical order. In recent years this last section has had several additions: the United States of Indonesia and Israel appear in this annual for the first time. The United Nations and their various offshoots have a long section to themselves, and the Council of Europe has several pages. The North Atlantic Treaty is given in full, and is illustrated by a coloured map. The other international organizations are also noted. Other valuable features are tables giving world production, for recent years, of wheat, rye, barley, oats, potatoes, sugar and cotton. An exhaustive index enhances the value of the book.

Introduction to Dynamics

By Dr. Martin Davidson. (Winchester Study Library.) Pp. 128. (London: Winchester Publications, Ltd., 1949.) 5*s*.

THIS book was written specially for students taking the London Matriculation and General Certificate examinations, and it certainly covers the syllabus for these examinations. In any book intended for students of this standard it is imperative to avoid using terms loosely; but one example of this occurs on p. 36, where the author says "the increase in the intensity of gravity—always denoted by the symbol g. . . ." In physics the term intensity has quite a technical meaning and should not be used for g, which, as the author certainly does say on p. 37, is an acceleration. One other small point: Would it not be better on p. 75 to define the unit of force in terms of acceleration and not of velocity, particularly in view of the fundamental equation $P = mf$ quoted a few lines down?

A number of useful problems are worked out in the text, and the author encourages students to work the exercises from first principles rather than from memorized formulæ; few will disagree with this course.

Although on the whole the author drives his points home very well, one feels that students would derive more benefit if the more important laws, deductions and equations had been emphasized by heavier print. Certainly the book would have a wider appeal if questions from other universities besides London had been included.

Makers of Mathematics

By Alfred Hooper. Pp. ix+402. (London: Faber and Faber, Ltd., 1949.) 18*s*. net.

THIS book caters for the general reader with but little mathematical knowledge, as well as for students and teachers of the subject who are interested in its historical background. The opening chapter, "The Birth of Numbers", not only describes the probable origins of systems of counting, but also includes an account of early materials for writing. The growth of geometry, algebra and trigonometry, and the invention of logarithms, are included in the first part of the book, followed by a chapter on the forerunners of Newton; the second half deals with such outstanding mathematicians as Newton, Leibniz and Gauss. The author successfully retains the reader's interest by introducing relevant matters of everyday practical concern: the clarity of the numerous diagrams also adds to this interest. Another feature is the biographical detail and historical association which have been woven into the story of the "Makers of Mathematics".

It is a tribute to the author that when explanations for the non-mathematician are introduced they do not detract from the general narrative. For example, the work of Jakob Bernoulli provides an opportunity of explaining polar co-ordinates and also of indicating by a diagram the nature and derivation of the lemniscate which bears his name. It will be realized that this book is not just another history of mathematics, but one of human activity and cultural value. A glance at the mathematical index shows the extensive range both of mathematicians and their work. The historical index indicates an equally extensive background of men and events rightly associated with the author's treatment of his theme. A list of books for further reading is provided.

H. D. Anthony

Beyond Realism and Idealism

By Wilbur Marshall Urban. Pp. 266. (London: George Allen and Unwin, Ltd., 1949.) 18*s*. net.

THE first impression made upon the reader of this competent and well-written book will be one of gratitude for a study involving years of patient thought and acute discernment. Whether it will, in fact, be possible to accept the author's thesis in full, time alone can show. This is, in brief, that the basic tenets of both realism and idealism are incapable of proof; that the "driving-force" of the latter will always encounter the "resistance" of the former, and that, consequently, a position of transcendence, indicating complementarity rather than contradiction, is both feasible and necessary. This discussion occupies rather more than half the available space; its character is frankly dialectical. By this is meant that the theme unfolds upon a plane of 'discourse' in contradistinction to one of 'things'. Thus it is no mere accident that the necessity to come down to earth brings with it a brave attempt to decentralize the sciences—which is in itself a valuable contribution—and to show that they themselves transcend realism and idealism, and therefore illustrate the contention previously elaborated. It is, however, a little difficult to believe that this *entente* is essential, or that the arguments in its favour are coercive. Nevertheless, they are plausible enough, and likely to enrich the content of scientific effort and research.

If any doubt should remain as to the positive value of such views, it is wholly dispelled by the masterly approach to the thorny subject of the present status and power of the *philosophia perennis*. Once again, this great tradition of European culture is seen to be able to take the strain, to yield what fraction of Aristotelianism no longer applies, and to look upon Scholasticism as something both fitting and useful, yet not as filling out the whole volume of human intellectualism. In a passage amounting nearly to pessimism, we are bidden to await the turn of the tide from its present anti-metaphysical surge. But some there are who think that they can just perceive its ebb.

F. I. G. Rawlins

SPECTROGRAPH FOR THE RADCLIFFE OBSERVATORY, PRETORIA

By Dr. J. JACKSON, C.B.E., F.R.S.

WHEN the decision was made, some fifteen years ago, to sell the site of the Radcliffe Observatory at Oxford, it was with the intention of using the proceeds for the construction of a new astrophysical observatory on a more suitable site. The final decision was to erect the new observatory near Pretoria in South Africa, and to equip it with a 74-in. reflecting telescope. The buildings and the mounting for the telescope were completed before the War; but failures in the casting of the large 'Pyrex' disk held up the work, and the figuring of the mirror was far from complete when war broke out. It was not until early in 1948 that the mirror was installed and brought into use.

At first no auxiliary apparatus was available; but some useful work was done by direct photography. Then a small spectrograph, weighing only a pound or two, was constructed for use at the Newtonian focus, and with it some fine spectra of faint stars and nebulæ have been secured. However, one of the principal projects envisaged when the observatory was planned was the determination of the radial velocities of stars in the southern hemisphere and particularly those of early-type stars in the southernmost parts of the Milky Way. These were specially wanted for investigations of the rotation of the galaxy, as the coefficients of the harmonic terms involved are determined with much greater accuracy if data are available for all galactic longitudes and not merely for those observable from northern stations.

A large spectrograph was therefore designed for use at the Cassegrain focus. The construction of this spectrograph was delayed by the War and has only recently been completed. It is hoped that it will soon be possible to start on the programme for determining radial velocities.

The optical arrangement is as follows. The light from a star or other celestial body is reflected upwards by the large 74-in. mirror. At some distance short of the principal focus it is intercepted by a secondary, convex, mirror which reflects it backwards down the tube so that it comes to a focus after passing through the central hole in the large mirror. Here it falls on the slit of the spectrograph. The collimator lens of 2·5 in. diameter and 45·4 in. focal length feeds the light through two 64° prisms with faces $2\frac{1}{4}$ in. × 5 in. For photographing the spectra there are four cameras with focal lengths varying from 4·75 in. ($f/2$) to 24·0 in. ($f/8$). The following table shows the length of the spectrum in inches for the various lenses:

Lens	λ3,700–λ4,200	λ4,200–λ5,000
f 8	1·51	1·25
f 6	1·08	0·90
f 3·7	0·64	0·53
f 2·0	0·36	0·30

The camera used will, of course, depend on the brightness of the object to be observed.

A spectrograph should be so mounted that the relative positions of the components from the slit to the photographic plate do not change while the exposures are being made. This is much more easily accomplished with laboratory spectrographs than with stellar spectrographs where the light is collected by a mirror moved by clockwork. Methods have been devised for bringing the light to a fixed position independent of the position of the telescope; but this involves the use of several mirrors and introduces new complications. Generally, the spectrograph is mounted on the telescope and is carried along with it by the clockwork. The problem is to keep a large spectrograph attached to a telescope free from distortion exceeding 0·001 mm. during an interval of an hour or more, while the orientation of the telescope relative to the direction of gravity is steadily changing.

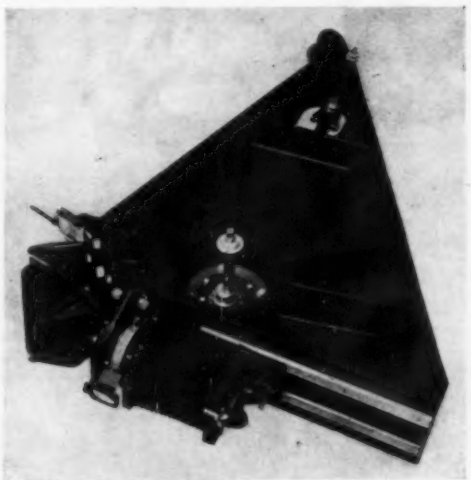

Fig. 1. Triangular frame and optical parts of the spectrograph, showing the method of support

For the Radcliffe telescope the optical parts of the spectrograph have been mounted on a rigid triangular frame (Fig. 1). This frame is supported at the point of least flexure on a pre-loaded self-aligning ball-bearing. Through the centre of this bearing passes an eccentric shaft, carried by fittings in a heavy fork casting which is firmly bolted to the telescope. Distortion of the fork does not produce distortion of the spectrograph. To restrain the frame from moving, a second eccentric shaft passes through it near its upper end carrying another, smaller, self-aligning bearing in a plane at right angles to the main bearing. The last restraint is provided by two adjustable floating pins bearing on the frame near the prisms. The collimator axis can be brought into coincidence with the telescope axis by means of the eccentric shafts and by sliding the frame along the shafts. The spectrograph is enclosed by aluminium sheet covers. The whole of the inside surfaces are covered with felt, on the inner face of which a network of electrical resistance wires is fixed. A sensitive thermostat controls the temperature to 0·2° C.

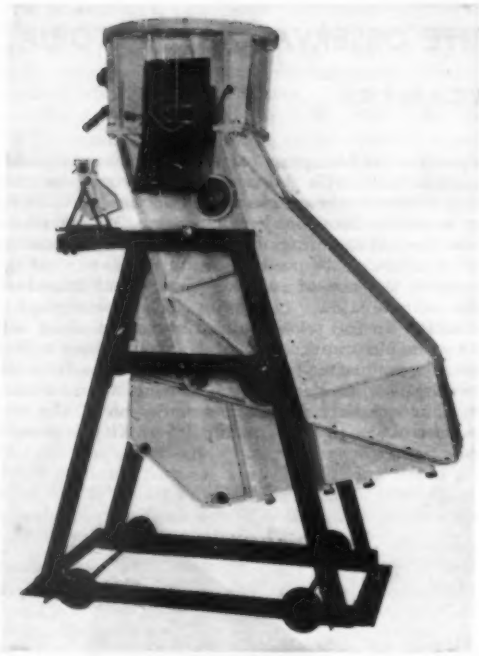

Fig. 2. Spectrograph on carriage, ready for attachment to telescope

The spectrograph is provided with the usual telescope for viewing the stellar image on the slit jaws. A second telescope enables observations to be made at the Cassegrain focus, or can be used for guiding when the star or nebula is too faint to be seen on the slit. For the determination of radial velocities, comparison spectra can be impressed on each side of the stellar spectrum from an iron arc or discharge tube.

It may be recalled that the telescope was made by Sir Howard Grubb, Parsons and Co. The spectrograph has been constructed by Messrs. C. F. Casella and Co., Ltd., the optical parts being made by Messrs. Adam Hilger, Ltd.

PROPERTIES OF MESONS

By Dr. H. P. NOYES*

PARTICLES of mass intermediate between the proton and the electron were first postulated by Yukawa in 1935 and discovered experimentally by Anderson in 1937; but for many years both their theoretical and their experimental properties remained obscure. However, the development of new photographic plate techniques and the artificial production of mesons have clarified the experimental situation considerably. Further, the recent developments in field theory have enabled calculations to be made with more confidence and accuracy than heretofore, so that a direct comparison of theory and experiment has become possible at many points. The result is that many of the properties of π- and μ-mesons can now be stated with some confidence, although detailed confirmation of several conclusions and the actual application of meson theory to the problem of nuclear forces remain to be accomplished. Still heavier mesons have been found in cosmic ray experiments, and their nature as yet remains obscure. However, the known properties of π-mesons can be used to establish certain tentative theoretical conclusions about these heavy mesons as well. This article is an attempt to summarize these various results.

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μ-Mesons

Consistency between widely differing methods of measuring meson masses indicates that both π- and μ-mesons possess the same charge as the electron within about 3 per cent. Further, several examples of $\pi \rightarrow \mu \rightarrow e$ decay have been seen, and the identification of the charged decay product of the μ-meson as an electron (see below) leaves little doubt on this score. Measurements of various kinds, summarized by Powell[1], give a unique mass for this particle of about 215 ± 5 times the mass of the electron.

Search for γ-radiation accompanying the decay of the μ-meson gave negative results[2]. By studying the *Bremsstrahlung* of the charged decay product, it was shown that this particle is certainly an electron[3]. Further investigation showed that these decay electrons are emitted with a continuous energy distribution, and the shape of this spectrum is now known[4]. The fact that the spectrum is not discrete shows that at least two particles are emitted in addition to the electron, while the measured average energy of the electron shows that, in fact, only two additional particles are involved. The spectrum is consistent with the hypothesis that these two particles are neutrinos, and the coupling constant for this decay is the same, within the rather wide limits of theory and experiment, as that for the β-decay of the neutron[5]. The lifetime of the μ-meson has been measured in many experiments as $2{\cdot}15 \times 10^{-6}$ sec.

The strength of the coupling of μ-mesons to nucleons can be calculated using the experimental fact that the rate of capture of negative μ-mesons by nuclei is about equal to the decay-rate in elements near atomic number 10. (That the decreased lifetime of negative μ-mesons in these elements is due to capture and not stimulated decay has been shown by demonstrating that an appropriate number of decay electrons are missing[6].) It is again interesting, although the significance is not clear, that the strength of this interaction is also approximately the same as for β-decay[7].

The result cited above that the μ-meson decays into an electron and two neutrinos shows that it has spin $\frac{1}{2}$. Hence, when a negative μ-meson is captured by a proton, a neutrino must be given off as well as a neutron being formed, and, in fact, this neutrino will carry off most of the energy. Calculations based on various models indicate that about 15 MeV. of excitation energy should be left in the nucleus. Consequently, on the average about two neutrons should be emitted for each negative μ-meson absorbed. Experimentally, this number is not well determined, but it lies somewhere near two[8]. Further, this much excitation energy should lead to the emission of a proton for about ten per cent of the time. This expectation has been confirmed by studying the stars produced by μ-mesons at great depths underground (where most of the π-mesons have been filtered out)[9]. Finally, the frequency of cosmic ray bursts at sea-

level produced by the *Bremsstrahlung* and knock-on electrons from μ-mesons agrees with the calculation for spin $\frac{1}{2}$ (if the latest mass value is used)[10].

Charged π-Mesons

The charge of these particles is almost certainly electronic, and the mass has the unique value 276 ± 6 electron masses[1]. These mesons are observed to decay into μ-mesons of a unique energy with a lifetime of somewhere between 1×10^{-8} and 3×10^{-8} sec.[11]. Energy and momentum balance show that the neutral particle emitted has negligible rest mass. Search for electron pairs along the track of the neutral particle through several radiation lengths of emulsion gave negative results, indicating that it is not a γ-ray. Hence (if we invent no new particles), it is a neutrino, and the π-meson has spin 0 or 1. Therefore, a π^--meson can be directly absorbed by a proton in a nucleus, delivering its rest energy to the resulting star, as is observed.

The experiments on meson production by X-rays[12] and fast protons on hydrogen go still further and tell us that π-mesons have spin 0 and are probably pseudoscalar rather than scalar particles. Charged mesons produced by the synchrotron X-ray beam are nearly isotropically distributed in angle and decrease in number with increasing meson energy. However, scalar and vector mesons would be produced with a strongly anisotropic angular distribution. This is because in these theories the meson cloud surrounding the nucleon extends to distances of the order of the meson Compton wave-length, and the electromagnetic field interacts strongly with the charge dipole induced in the system much as in the atomic photo-effect. Pseudovector mesons would be produced more or less isotropically due to strong interaction with the meson magnetic moment, but the number produced would increase very rapidly with meson energy. This is due to the strong electromagnetic interaction of mesons of spin 1, already used by Christy and Kusaka[13] to show that cosmic ray mesons cannot be of this type. Pseudoscalar mesons have the desired features in lowest-order perturbation theory, and these features (isotropy, decreasing cross-section with increasing meson energy) persist when the next-order calculations are carried out[13]. This occurs because in the pseudoscalar theory the mesonic charge cloud is confined to much smaller regions than in the scalar case, and the electromagnetic field interacts primarily with the magnetic moment of the nucleon. In all cases we see that the differences between the theories depend on general characteristics and are to a large extent independent of detailed calculations.

When the positive meson sometimes produced in the collision of two energetic protons carries off the maximum energy available to it, the neutron and proton have zero relative momentum and interact strongly. Calculation shows that if they are in a triplet spin state they can even end up bound as a deuteron and that this is about four times as probable as their ending up as free particles[14]. Consequently, the positive meson spectrum from hydrogen can show an enormous peak at this energy relative to the continuous spectrum, which is, in fact, observed[15]. When a scalar meson is produced near threshold, the neutron and proton come off in a singlet state, and the peaking to be expected (due now to the near resonance of the singlet state at zero energy) is not nearly so pronounced. However, the production of pseudoscalar mesons can lead to a triplet final state for the nucleons and to the observed spectrum, confirming the conclusion already drawn that the π-meson is pseudoscalar. In this case the conclusion depends more on the details of the theory and is less trustworthy than the general arguments used in the discussion of the production of photomesons.

Neutral π-Mesons

The first direct evidence for the existence of neutral mesons came from the study of γ-radiation produced by high-energy protons striking nuclei[16]. This radiation was a hundred times as intense as the *Bremsstrahlung* to be expected in such collisions and appeared with approximately the same threshold and energy dependence as charged mesons. The spectrum at various angles was shown to have the same (symmetrical) shape peaked at 70 MeV. when transformed to a co-ordinate system moving with the centre-of-mass velocity of the incident proton and target nucleon, as would be expected if it were in fact due to two γ-rays resulting from the decay of a neutral meson of approximately the same mass as charged mesons. Similar radiation is also produced by the high-energy X-ray beam striking nuclei; and, by studying the angular correlation of coincidences between two γ-rays, it can be shown that these γ-rays are, in fact, the unique decay products of neutral particles produced with approximately the same energy distribution and cross-section as charged mesons[17]. The fact that the neutral π-meson decays into two γ-rays proves that it has spin 0, as this mode of decay is strictly forbidden for particles of spin 1. By studying the electron pairs in emulsions exposed at 70,000 ft., it has been shown that neutral mesons are produced as often as positive or negative mesons and with the same energy distribution. Further, by measuring the perpendicular distances from the star in which the neutral meson is produced to the line of the pair, it can be shown that the neutral meson has a lifetime of less than 5×10^{-14} sec. and possibly of about half that figure[18].

The mass of the neutral π-meson is determined quite accurately by the reaction $\pi^- + p \rightarrow \pi^0 + n$, which has been observed in hydrogen[19]. This immediately shows that the neutral meson must be lighter than the negative meson by at least the neutron–proton mass difference, and, by using the Doppler shift of the decay γ-radiation and momentum and energy balance, it is found that it is lighter by $10{\cdot}6 \pm 2$ electron masses. If this mass difference is introduced into the usual 'symmetric' theory of nuclear forces, there is no longer exact equality between n–p and p–p forces.

Using the fact that both charged and neutral mesons have spin 0, this reaction also shows that the neutral meson has the same parity as the charged meson and hence is pseudoscalar. This is because the negative meson is presumably captured from a K-orbit, and if the neutral meson of 2–3 MeV. has opposite parity, it cannot come off in an S-state, so that the reaction $\pi^- + p \rightarrow \gamma + n$ will be highly favoured instead of occurring with comparable probability as is observed. This conclusion is borne out by calculating the meson–nucleon coupling-constants from the observed branching-ratio between the two reactions; these constants are reasonable if charged and neutral mesons have the same parity, but are five hundred times larger otherwise[20]. The further observation that the reactions $\pi^- + d \rightarrow \gamma + 2n$ and (probably) $\pi^- + d \rightarrow 2n$ occur, whereas $\pi^- + d \rightarrow \pi^0 + 2n$ is not seen[21], strengthens this conclusion.

Another indication that the neutral meson is pseudoscalar is given by the fact that even near threshold it is produced by both X-rays and protons in comparable numbers to charged mesons. However, to the lowest non-vanishing order of perturbation theory, the cross-section for the production of neutral mesons of all types is smaller than that for charged mesons by the square of the ratio of meson to nucleon mass. In pseudoscalar theory, however, the next-order contribution is much more important, and, in fact, will give the observed equality between charged and neutral cross-sections for a reasonable choice of the coupling-constant[23]. Clearly, this argument depends on the details of the theory, and therefore merely shows that the equality of cross-sections is not inconsistent with pseudoscalar theory.

Heavy Mesons

Until recently, the existence of particles intermediate in mass between the π-meson and the proton had not been conclusively demonstrated, and the properties of these particles are still only vaguely known. They appear in different kinds of experiments, and even the question whether one or more basic types of particle are involved is not clear. At least three examples have been found of a heavy particle that decays at the end of its range into three lighter particles[25]. In one case one of these decay particles gives a star at the end of its range, and hence can be identified as a π^--meson. The other decay particles could be either π- or μ-mesons, but can be shown not to be protons or electrons. The parent particle must have existed long enough to give the track coming to rest in the emulsion and therefore has a lifetime greater than 10^{-12} sec. If the decay particles are, in fact, π-mesons, as we would expect if the heavy mesons are strongly coupled to nucleons, the masses of the heavy particles are roughly 900–1,000 electron masses. Another particle of about this mass was observed to collide with an electron in a cloud chamber[24]. Five examples have been found of particles of above 700 electron masses, which come to rest in emulsion and give stars of about this total energy; sometimes a π-meson is produced in this star[25]. There are now more than thirty cloud-chamber pictures of neutral particles, which are apparently produced in the lead block above the chamber or in a lead plate across the chamber, and which decay into two charged particles of opposite sign much heavier than electrons; the possibility of a neutral particle also being emitted is not completely excluded[26]. One of the decay particles is scattered through an angle of 35° on passing through the lead plate, while another causes a nuclear explosion in the plate, indicating that the decay particles have a cross-section for causing nuclear events consistent with their being π-mesons. From the distance the neutral particle travels before decaying and its energy, its lifetime can be calculated as $3 \pm 2 \times 10^{-10}$ sec. The number produced can then be calculated from the number observed to decay in the chamber, and it is found that these particles are produced 3 per cent as often as penetrating radiation, indicating that they may well be nearly as strongly coupled to nucleons as π-mesons. A second heavy particle appears five times in these same experiments. It is charged and decays into a lighter charged particle (which is not an electron) and one or more neutral particles. Its lifetime is less than that of the neutral particle, but not by an order of magnitude. It is about as strongly coupled to nucleons as the neutral particle.

Clearly, the above results do not specify the properties of these heavy mesons very completely. If the foregoing two-particle decays actually involve a third neutral particle as well, it is possible that all heavy mesons observed thus far are charged or neutral versions of the same type of entity. But it is difficult to see what type of particle could be expected to decay alternatively into either two or three π-mesons with about the same probability; so that if the cloud chamber experiments show genuine two-particle decays, at least two types of heavy meson can be expected. The indication that some heavy mesons, at least, are strongly coupled to nucleons has an important theoretical consequence. If they have spin 1, they can produce virtual nucleon pairs which then annihilate each other to give a π-meson and a γ-ray; this process has such a high probability that such heavy mesons could not exist long enough to be observed[27]. Hence, heavy mesons strongly coupled to nucleons must have spin 0, making this process forbidden. Further, in order that three-particle decay be observed, two-particle decay probably has to be forbidden[28]. Since π-mesons are pseudoscalar, this implies that the heavy meson which decays into three π-mesons is also likely to be pseudoscalar. Unfortunately, both these conclusions cannot be made certain until those parts of the calculations which lead to infinite answers can be unambiguously interpreted, and they should at present be regarded as more or less speculative.

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INTERNATIONAL CONVENTION FOR THE PROTECTION OF BIRDS

ON the invitation of the French Government, a conference was held in Paris during October 17–18, 1950, to discuss proposals put forward by the International Committee for Bird Preservation for the revision of the International Convention for the Protection of Birds useful to Agriculture, signed in Paris on March 19, 1902. In addition to France, the following countries were represented: Austria, Belgium, Denmark, the Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey and the United Kingdom; Bulgaria and Greece sent observers. The conference was opened by M. Merveilleux du Vignaux (directeur-général des eaux et forêts), representing the Minister of Agriculture, and the delegates were welcomed by Prof. Rene Jeannel, director of the Muséum d'Histoire Naturelle where the meetings were held. Prince Paul Murat, chairman of the French National Section, International Committee for Bird Preservation, was elected to preside over the deliberations and in his opening speech gave a survey of the history of events leading up to the present Convention.

The first attempt at bird preservation on an international scale appears to have originated at the twenty-sixth general assembly of German agriculturists and foresters, held in Vienna in 1868, when a resolution was sent to the Minister of Foreign Affairs of Austria-Hungary to request the Government to join with other countries to procure international agreements for the protection of animals useful to agriculture and forestry. This resolution was accepted on condition that the agreements should be restricted to the protection of birds useful to agriculture, and negotiations with other countries were commenced.

The first project was to form a series of treaties; but it was soon realized that an international convention setting forth certain declarations of principles in general clauses would be more efficacious. In 1872, therefore, the Swiss Federal Council, supported by the German Government, proposed the formation of an international commission to draft an agreement; but the commission never met, as preliminary negotiations failed. Individuals, however, continued to work on the question, and in 1873 at the International Agricultural Congress in Vienna the problem of the protection of birds was included in the agenda. It was proposed by the Swiss delegate, and agreed, that the Austrian Government should draw up a draft convention based on various points which had been put forward. This was carried out, and in 1876 a draft convention was sent to a number of European countries but did not arouse much interest.

Little progress was made until the matter was raised at the First International Ornithological Congress, in Vienna in 1884. At this meeting the æsthetic as well as the economic point of view in bird protection was put forward; but there was much dissension on the subject of useful and harmful birds, and the only practical result was the setting up of a permanent international Ornithological Commission charged with the elaboration of a proposal to be discussed at the next Congress in Budapest; but the Commission never met.

At the Congress in Budapest in 1891, bird protection formed a large part of the programme, and a resolution was sent to the Ministers of Agriculture in Austria and Hungary requesting them to take steps to promote an international convention for the protection of birds useful to agriculture. From then on, a far wider interest in bird preservation was shown throughout Europe, and in 1895 a conference on the protection of birds was held in Paris at which a draft convention of ten clauses was put forward by the French Government. After a good deal of argument, particularly with regard to the schedules of birds considered beneficial or harmful, a modification of the proposals was provisionally accepted by a number of countries, but others, including Great Britain, withdrew from the discussions. Nothing further was done until the Third International Ornithological Congress met in Paris in 1900, when it was agreed that the Governments of European countries should be asked to study the food habits of wild birds in order that they might be separated into useful and harmful species. This was a somewhat tardy step, and in point of fact little work was done; but the interest aroused nevertheless resulted in the International Convention for the Protection of Birds useful to Agriculture, which was signed in Paris in 1902 by the representatives of Austria, Belgium, France, Germany, Greece, Hungary, Luxembourg, Monaco, Portugal, Spain, Sweden and Switzerland, other countries being given the possibility of adhering later. The Convention accorded protection to certain birds enumerated as useful and also to their nests, eggs and young, while another list of species pronounced harmful was excepted from protection. Certain methods of taking and killing birds were prohibited, as also the sale of protected birds during the close season. France, Belgium and Hungary ratified the Convention, Sweden shortly followed suit and, at a later date, the Netherlands announced the intention of adhering to the Convention.

No modifications were made to the Convention in the ensuing years, and, though at an international conference on bird preservation, held in Luxembourg in 1925, a commission was set up to study the possibility of modifications to render the Convention more effective, nothing resulted. The subject of bird preservation had always formed part of the deliberations of the International Ornithological Congresses, but it was agreed at the Eighth Congress, held in Oxford in 1934, that this subject should in future be left entirely to the International Committee for Bird Preservation which was formed in 1922.

In 1935 the Finnish, Norwegian and Swedish Governments drew up a draft convention which was put before a conference in Brussels that year of the International Committee for Bird Preservation; but it was agreed that an entirely new convention was not practicable and that proposals for the revision of the Paris Convention of 1902 should be drawn up. The subsequent action taken by the International Committee for Bird Preservation has already been described[1]; and it was reported how, after two years of work by an international sub-committee, the proposals were completed and agreed at a meeting in Vienna during 1937 of the International Committee for Bird Preservation and were laid before the French Government. The intervention of the Second World War, however, prevented further progress. In 1947, at a meeting in London of the International Committee, it was decided that, in view of the increased knowledge of, and progress in, bird preservation, the proposals should be further revised, and work was begun again, the new proposals being agreed in Paris in 1948.

The present revised Convention has far more hope of success than its predecessor, for it is broader in outline and the vexed question as to whether birds are harmful or beneficial does not enter into it; also, the inclusion of schedules of species which caused so much disagreement in the past has been abandoned—each country is left to draw up lists or schedules according to its particular needs. The main principle is the acknowledgment that all birds should have some measure of protection, at least during their breeding season and, in the case of migratory birds, during their return to their nesting sites. Birds in danger of extinction or of particular scientific interest are protected at all times, and all measures of protection include nests, eggs and young. The traditions and needs of local populations are appreciated, and exceptions for scientific research, protection of crops, etc., and control of birds harmful to other species are provided for. Certain methods of taking and pursuing birds are prohibited; but the various countries are given time in which to bring such measures into force. Import, export, transport, selling and buying of birds are also dealt with. Governments are urged to take measures to prevent the destruction of birds by oil pollution of waters, by lighthouses, electric wires, insecticides, poisonous substances and other dangers, and to educate children and public opinion on the necessity for bird preservation. An entire article of the Convention is devoted to the need for bird reserves, which is a matter of ever-increasing urgency all over Europe.

The Convention was signed *ad referendum* on behalf of their Governments by all delegates present (France in addition being empowered to sign on behalf of the Principality of Monaco), and other Powers have the right to adhere at a later date. The United Kingdom was represented by Mr. H. McCullagh, of the Home Office, with Sir Norman Kinnear and Miss Phyllis Barclay-Smith as technical advisers.

[1] *Nature*, **162**, 422 (1948).

LIFE AND WORK OF AUGUSTO RIGHI

By Dr. A. von ENGEL
Clarendon Laboratory, University of Oxford

In September 1950 the Italian Physical Society, together with the University and the City of Bologna and the Italian Institution of Electrical Engineers, celebrated the centenary of the birth of Augusto Righi, once Italy's leading physicist[1]. Righi was a well-known figure both in his own country and abroad, unassuming and versatile, and an ingenious and skilful experimentalist with a strong theoretical background. Born and educated at Bologna, he first read civil engineering and later turned to physics. He started his career in 1872 as senior demonstrator to E. Villari, who was professor of physics in the University of Bologna, and became a year later head of the physics department and assistant professor in the Technical School of Bologna. In 1880 he was appointed to the chair of physics in the University of Palermo. Five years later he went to Padua, and returned in 1889 to Bologna, where he held the chair of physics until his death in 1920.

The outstanding contributions by Righi were recognized by many learned societies. In 1875 he won a prize (1,000 lire) of the Academy of Science at Bologna, in 1891 the King's Prize for Physics (10,000 lire) of the Reale Accademia dei Lincei and in 1905 the Hughes Medal and Prize of the Royal Society. He was elected an honorary fellow of the Physical Society (of Great Britain) in 1903, a foreign member of the Royal Society (1906) and of the Royal Academy at Uppsala (1908). Other honours that Righi received were the honorary membership of the Institution of Electrical Engineers (of Great Britain) in 1917 and of the Imperial Academy of Science in Moscow (1914), his election as senator of the Italian Parliament (1905), and the degrees of doctor *honoris causa* of the Universities of Göttingen, Erlangen, etc.

Righi's interest covered a great variety of physical problems. His first paper appeared in 1872. Altogether he published about 240 papers and several books[2]. In 1888, that is, at about the same time as Hallwachs in Germany, he discovered that a substance can become positively charged under the influence of light; the first signs of a photo-electric effect had been observed by Hertz a year earlier. Righi found that when a radial electric field is applied to a hollow cylinder of a solid dielectric substance it suffers a change in length (1879). He searched in vain for an 'electrostriction' of a metallic conductor through which a current was passed. At the same time as Leduc (1883), Righi discovered that the thermal and electric conductivities of bismuth decrease in the presence of a magnetic field and that a temperature difference is established in a direction perpendicular to that of a heat flow and the magnetic field.

Righi carried out a large number of experiments to verify the identity of electromagnetic radiation and light waves. He developed the well-known oscillator consisting of two metal spheres which were immersed at a variable distance in an oil-filled compartment. These oscillators produced radiation of a wave-length of 3–20 cm. For detecting short waves he used oblong glass plates of a few millimetres width, one side of which was covered with a silver layer. The latter was ruled along the middle and formed a micro-gap, the sparks being observed with a magnifying glass. He investigated the reflexion of electromagnetic radiation from metals and dielectric substances and found good agreement with Fresnel's equations, which give the intensities of the reflected and refracted ray as a function of the index of refraction and the angle of incidence. He investigated total reflexion by means of a prism and made extensive experiments with simple interferometers in order to determine the refractive index of paraffin and sulphur. He used electromagnetic waves to carry out the two-mirror and the biprism experiments of Fresnel. Moreover, he investigated the diffraction on slits, dielectric cylinders and gratings which were made of parallel wires; he also studied polarization and birefringency.

Another of Righi's main fields of interest was the conduction of electricity in gases. So early as 1876 he found that the sparking potential in air does not depend on the substance of the electrodes. In 1890 he found that an ionization current which flows between two plane-parallel electrodes—one of which is irradiated with light—passes a maximum when the gas pressure is gradually increased. The explanation was later given when the variation of Townsend's ionization coefficient with the electric field was understood. Righi studied extensively the influence

of magnetic fields on glow discharges. At one time he thought that the variation of the dimensions of the negative glow was due to what he called magnetic rays. He investigated the discontinuous glow discharge in the now well-known circuit containing a resistance in series with the discharge and a condenser parallel to it, and it is a sign of his great experimental skill that he was able to record in 1902 with a cathode-ray oscillograph the current in the discharge.

In later years Righi gave his interpretation of the measurements of the velocity of light by Michelson and Morley, and suggested an experiment to test the validity of the theory of relativity. Students of the history of physics will find extracts of all Righi's papers in a forthcoming book by G. C. Dalla Nocce and G. Valle (in Italian)[3].

[1] See Lodge, Sir Oliver, *Nature*, **105**, 753 (1920).
[2] Cardani, P., "In memoria di A. Righi", *Nuovo Cim.*, **21**, 53 (1921).
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OBITUARIES

Mr. B. W. Tucker

BERNARD WILLIAM TUCKER, who died on December 19 after a long illness, was not only one of the most influential leaders in the field of ornithology but also a scholar with a profound knowledge of vertebrates in general. By his early death, the Oxford School of Zoology has suffered a severe loss. He was born on January 22, 1901, and educated at Harrow and Magdalen College, Oxford. After graduating in 1923, he went with the Oxford Scholarship to Naples and began an investigation of parasitism in the Crustacea, which took him back to the Stazione Zoologica on several subsequent occasions. During this period he was a demonstrator in zoology at Cambridge for a time, but he returned to Oxford in 1926 and in the following year was appointed University demonstrator and lecturer in zoology and comparative anatomy.

Tucker had been a keen naturalist since his early schooldays, and throughout his life he was specially interested in amphibians, reptiles and birds. His most important contribution to zoological literature was his share in the greatly enlarged and revised five-volume edition of Witherby's "Handbook of British Birds" (1938–41); he was responsible for those sections dealing with habitat, field characters, general habits, voice and display. He obtained this information for every species on the British List, and for many of them their field characters had never been described before; to do all this he made numerous expeditions to various parts of Europe from Spitsbergen and Lapland in the north to the Mediterranean countries in the south. It was his enthusiasm, combined with good judgment and a scrupulous regard for exact observation and description, that made him so important a figure in ornithology. Dr. David Lack writes: "The accuracy and wide scope of his notes set a new standard not only for British birds but for the birds of the world". He brought the same qualities to his editorship of the magazine *British Birds*, which he took over as a labour of love when his great friend H. F. Witherby died.

Although associated with others, Tucker was above all the moving spirit in the development of bird studies in Oxford from the founding of the Oxford Ornithological Society in the 'twenties through a series of events leading to the establishment of the Edward Grey Institute of Field Ornithology in the 'thirties, and its final incorporation as a definite part of the University and a branch of the new Department of Zoological Field Studies in 1947. Oxford did well to honour him by giving him the title of reader in ornithology in 1946. He was a delegate of the University Museum and devoted much time to the care of the zoological collections; he had extensive plans for the improvement of the display of exhibits when his last illness overtook him.

Colleagues and pupils will always remember his gentle, charming manner, his characteristic smile and his readiness to help others whenever he could.

A. C. HARDY

Dr. G. H. Culverwell, O.B.E.

DR. G. H. CULVERWELL, chief inspector in the Home Office under the Cruelty to Animals Act, 1876, died on December 9, at the age of sixty-three.

Culverwell's early years were spent in the School Medical Services, after which he became an inspector in the Home Office in what eventually became the Children's Branch. His duties were concerned with the conditions prevailing in the 'approved schools' and he was largely responsible for many improvements—especially housing and dietary—which took place during his term of office. There he made his mark and he was duly honoured.

Then his career took an entirely different turn; after some hesitation, he was persuaded to accept an invitation to join the inspectorate under the Cruelty to Animals Act, 1876, and thus a long and happy association began. His intellectual qualities, sound judgment, courteous manner and placid temper made him a most agreeable colleague.

I like to remember Culverwell for his valuable work during the Second World War. During this period unusual experiments involving the use of living animals were devised for testing lethal weapons and to ascertain the measures to be adopted to protect troops and civilians. The nature of the work sometimes brought him into conflict with the research workers, for in such an emergency the rights of the animal are apt to be overlooked. Culverwell, however, followed the rigid principle of holding a proper balance between the merits of a research and the interests of the animal, and his view was generally accepted with good grace. Culverwell was concerned with an Act which gives remarkably little direction. He never tired of making its provisions clear to research workers, and the medical research world owes a deep debt of gratitude to him.

Culverwell was working right up to the onset of his last illness, in spite of the indifferent health of his later years.

J. A. GILES

PROF. E. B. VERNEY, Department of Pharmacology, Cambridge, writes: "Though it was Culverwell's work to see that the law was maintained, his belief in the value of humanity was so great that it inspired a kindly attitude in all laboratories he visited. It was recognition of this belief that showed investigators that he was there to help and not to hinder; and such was his kindness that exacting discipline could be enforced and cheerfully accepted. Although his position was essentially administrative, his wise counsel was always available, and he will be sorely missed by the many who have turned to him in their difficulties."

Mr. H. J. Turner

Henry Jerome Turner was the last of a circle of notable amateur British entomologists who, around the turn of the century, rediscovered and popularized the study of European butterflies. The entomological journals of the period are full of descriptions of their doings in France, in the Alps, in Austria, Spain, the Balkans, Scandinavia and elsewhere, and these descriptions are all the more readable because the authors, while adding greatly to our detailed knowledge of the European fauna, remained very human and could write of the people and the scenery as well as the 'bugs'.

Turner was the only son of a Redhill builder and was born on August 27, 1856. By profession a schoolmaster, he early obtained a position under the London School Board and eventually became headmaster of Denmark Hill School, which by sheer hard work and strict discipline he turned before long into a model. He had early shown an interest in entomology; but it was not until he joined the South London Society in 1887 and came under the spell of J. W. Tutt that this interest was given point. Tutt was then engaged on his "Natural History of British Lepidoptera". Turner became one of his most devoted disciples, and after his death in 1911 took over the editorship of the *Entomologist's Record*, which Tutt had founded in a moment of frustration and iconoclastic frenzy in 1890. In 1894 he had become editorial secretary of the South London Society; this post too he held for some forty years. Not content, he shouldered responsibility for the Library of the Royal Entomological Society of London in 1921 and supervised its removal from Chandos Street and resuscitation at Queen's Gate in the succeeding years. He was elected honorary life president of the South London Society in 1944 and a special life fellow of the Royal Entomological Society in 1948.

It is perhaps not surprising that with so much to do Turner produced little original work. His most notable publications were largely of a bibliographical nature, such as his supplement to Tutt's "Varieties of the British Noctuae", which he commenced to issue in odd pages twenty-five years ago as a supplement to the *Entomologist's Record*, and now is unlikely ever to be finished. His "Butterflies of Cyprus" was his chief contribution to faunistic knowledge. A little man, bolt upright and of rather rigid views, Turner was every inch a schoolmaster and had been a figure in London entomological circles, and internationally, for more than sixty years when he passed away, still at work, on December 19, mourned by a very wide circle of friends. N. D. Riley

We regret to announce the following deaths:

Prof. G. T. R. Evans, head of the Department of physics in the University of the Witwatersrand, on December 20.

Academician Sergei Vavilov, president since 1945 of the Academy of Sciences of the U.S.S.R., known for his work on photoluminescence, on January 25, aged fifty-nine.

NEWS and VIEWS

Dr. H. Hamshaw Thomas, M.B.E., F.R.S.

Dr. Hamshaw Thomas, an international authority on palæobotany, who has been associated with the Botany School in the University of Cambridge for the past forty years, retired from his teaching posts in the University and in Downing College on September 30 last. Appointed curator of the Museum in 1909, he has taken an active part in the teaching of botany at Cambridge since that time, except for two periods of more than four years during the two World Wars, when, as a serving officer in the R.F.A., R.F.C. and R.A.F., he was concerned with the development of aerial photography and of air photographic intelligence. He was appointed a University lecturer in 1923 and reader in plant morphology in 1937. From 1920 he was secretary of the Botanic Garden Syndicate, and for many years assisted the professors of botany in the administration of the Department. During 1914–50 he held a fellowship at Downing College, and was director of biological studies there from 1919 onwards; he had also held the offices of dean and steward in his College, which has now elected him to an honorary fellowship. Dr. Thomas's scientific work was recognized by his election to the Royal Society in 1934, to the presidency of Section K (Botany) of the British Association in 1947, and to the presidency of the Section for Palæobotany at the Seventh International Botanical Congress in 1950. He has also taken an active part in the promotion of the study of the history of science in Cambridge since 1935. Dr. Thomas's retirement from active teaching will, it is hoped, give him leisure to develop further those particular interests with which his name is associated.

Cambridge Botanic Garden: Mr. H. Gilbert-Carter

Mr. H. Gilbert-Carter relinquished his positions as director of the Botanic Garden and University lecturer in botany, Cambridge, at the commencement of the present academic year, having reached the age of retirement. He had entered the University of Cambridge as a research student after taking a degree in medicine at Edinburgh, and later joined the staff of the Indian Botanical Survey. He returned from Calcutta to become director of the Botanic Garden at Cambridge in 1921; in the same year he was also appointed curator of the Herbarium in the Botany School. He held the latter post until 1930, when he was appointed a university lecturer. For more than twenty-five years he has been mainly responsible for the teaching of the taxonomy of the flowering plants at Cambridge, and he proved to be a most stimulating teacher. During his directorship the Botanic Garden passed through a long period of financial difficulty, relieved by generous gifts from Mr. Reginald Cory and other benefactors. In spite of this, the scientific and æsthetic value of the Garden has been well maintained.

Royal Horticultural Society's Gardens, Wisley: Mr. J. L. S. Gilmour

Mr. J. L. S. Gilmour, director of the Royal Horticultural Society's Gardens at Wisley, who has been appointed to succeed Mr. Gilbert-Carter at the Cambridge University Botanic Garden, is well qualified for the post. For a short time after graduating at Cambridge he was curator of the University Herbarium, and during that period was in constant touch with work in the Botanic

Garden. In 1931 he was appointed assistant director of Kew Gardens. During the Second World War he was seconded to the Petroleum Division of the Ministry of Fuel and Power, where he was principal officer during 1940–44. In 1946 he was made director of the Royal Horticultural Society's Gardens at Wisley. The experience gained in these exacting posts will stand him in good stead in the work before him. Mr. Gilmour has great energy and diverse interests. He is joint editor of the *New Naturalist*, and has been secretary of the Systematic Association and chairman of the Botanic Society and Exchange Club. Outside botany his main interests are music and books. Many will remember with pleasure the lunch-time concerts in his house at Kew. Mrs. Gilmour played a prominent part in these concerts.

Dr. H. R. Fletcher

Dr. H. R. Fletcher, who succeeds Mr. Gilmour, graduated at Manchester in 1929, and in the same year was appointed assistant lecturer in botany in the University of Aberdeen under the late Prof. Craib. There he became interested in taxonomy, especially in the flora of Siam, and in the administration of the Cruickshank Botanic Garden. After taking his Ph.D., Dr. Fletcher was appointed to the staff of the Royal Botanic Garden, Edinburgh, in 1934. There for a time he continued his work on the Siamese flora, and graduated D.Sc. in 1939. But since Chinese plants are very richly represented in the Edinburgh Herbarium and Garden, he inevitably turned to the flora of China, and particularly to those plants of the Western Chinese Alps which have proved to be of outstanding horticultural importance. In collaboration with Sir William Wright Smith, he published a long series of papers on the sections of the genus *Primula* (*Trans. Roy. Soc. Edin.*, *Trans. Bot. Soc. Edin.*, and *J. Linnean Soc.*). Then followed a revision of the genus *Omphalogramma* and numerous articles in scientific and gardening journals on the genera *Codonopsis*, *Cremanthodium*, *Aconitum*, *Potentilla* and *Incarvillea*. Research apart, Dr. Fletcher has for many years acted as tutor to the botany class arranged by the Edinburgh Workers' Educational Association. He is also honorary secretary of the Botanical Society of Edinburgh. He has given courses of instruction to the student gardeners in Edinburgh on taxonomy and on the principles of botany as applied to horticulture, and was partly responsible for the planning of the syllabus of the Edinburgh diploma in horticulture.

Rutherford Memorial Fund

On November 30, an appeal for a memorial to the late Lord Rutherford was launched by the Royal Society (see *Nature*, December 2, p. 917). A total of £100,000 was mentioned as the sum required to establish scholarships on an adequate scale, and it is very gratifying to learn that nearly £60,000 has been already received from companies, many of them industrial firms, and individuals in the United Kingdom. In view of the special difficulties of the times, this speedy response is very encouraging. The Dominions of Canada, Australia and New Zealand are taking special steps to collect funds in their respective countries. The Memorial Committee is, however, anxious that the total sum raised and the portion contributed by the United Kingdom shall be as high as possible, and it invites further contributions.

West African Institute for Trypanosomiasis Research

Sir John Macpherson, Governor of Nigeria, opened the West African Institute for Trypanosomiasis Research on January 31. The Institute, which is partly at Kaduna and partly at Vom, will undertake further research into all aspects of human and animal trypanosomiasis, including studies on the insect carriers of this group of diseases and experimental work with the various trypanocidal drugs. It will maintain a central library and museum, and serve as an information and advice bureau on all problems connected with sleeping sickness and animal trypanosomiasis. The cost of the Institute, £234,000, has been met under the Colonial Development and Welfare Acts, which have borne two-thirds of it, and the remainder by the Governments of Nigeria, the Gold Coast, Sierra Leone and the Gambia. Colonel H. W. Mulligan, of the Indian Medical Service, formerly director of the Central Research Institute, Kasauli, was appointed Director of the Institute in 1947, and he has been responsible for acquiring sites and preparing plans for administrative, laboratory and ancillary buildings as well as for the other tasks of organization involved in starting an entirely new research institute. It is expected that men of science from other countries will visit the Institute as guest workers from time to time. The affairs of the Institute are in the hands of a statutory managing committee of which the Chief Secretary of the West African Council is chairman, and on which the director of the Institute also sits; the various members are nominated by the West African Governments, while the director and chairman are appointed by the Secretary of State.

British Museum (Natural History): Acquisitions

The Northern Rhodesian Administration has presented to the Department of Mineralogy of the British Museum (Natural History) a large number of meteoritic stones, the first recorded in Northern Rhodesia, which formed part of a shower of meteorites that fell some ten or fifteen miles north-west of Monze Township (between Livingstone and Lusaka) at 4.10 a.m. on October 5, 1950. A brilliant meteor was observed low over the district, and shortly afterwards a violent explosion was heard and a shower of small stones fell over a radius of about two miles, the majority of the stones having diameters of $1\frac{1}{2}$–$2\frac{1}{2}$ inches. There were no casualties to man or beast. The Department of Botany has recently acquired two collections. The first has been presented by Colonel R. Meinertzhagen and consists of his valuable herbarium of more than five thousand specimens, including flowering plants, ferns and fern allies, and marine algæ. The collection has been excellently preserved; and, as many of the specimens have been obtained from remote areas of Africa and Asia from which the Museum previously had no material and in which little collecting has been done, the material is thus a very valuable addition for the Museum. The second acquisition of the Department of Botany is the collection of approximately 650 botanical specimens (flowering plants, vascular cryptogams, a few mosses, hepatics and lichens) gathered in 1950 by Colonel D. G. Lowndes in the previously unexplored region of the Anapura Himal, Nepal. The bulk of the collection comes from a valley on the borders of Nepal and Tibet, screened from the monsoon, and it is anticipated that this material will provide data of considerable phytogeographical interest.

The Irish Astronomical Journal

The first meeting of the council of the Irish Astronomical Society was held on June 14, 1947, at Armagh Observatory, and this new Society has issued the first two numbers of a quarterly periodical, *The Irish Astronomical Journal* (1, No. 1, pp. 36 (March 1950), and No. 2, pp. 37–68 (June 1950); Armagh: the Observatory; 3*s*. each or 10*s*. annual subscription). These two numbers show a remarkable interest in astronomy, both in Northern Ireland and in the Republic of Ireland, and it is worth recording that each government has given £5,000 towards the new planetarium which is to be installed at Armagh; this will be the first planetarium in the British Commonwealth. The issue for March 1950 contains a description of the programme and instruments at Armagh Observatory and is written by Dr. E. M. Lindsay, director of the Observatory, which is now closely connected with Queen's University, Belfast. Students taking the astronomy course make use of the facilities of the Observatory, and Dr. E. B. Armstrong, a member of the Armagh staff, is a lecturer in the Department of Astronomy. Among the contributions to the March 1950 issue are papers, among others, by the following: Dr. H. A. Brück, director of the Dunsink Observatory, giving a short history of the Observatory since it was founded in 1783 and an account of the present equipment and programme; E. M. Lindsay, "Exploring between the Stars"; A. P. Fitzgerald, "Mercury; an Historical Error"; James Paton, "The Aurora Borealis"; E. J. Öpik (also on the Armagh staff), "Mars and the Asteroids". There are also an "Astronomical Diary for 1950", "Reports of Meetings", "Queries and Answers", etc. The June issue contains equally interesting papers, the first of which, by E. J. Öpik, on "Dust and the Planets", provides, *inter alia*, an excellent survey of the most recent knowledge of the physical conditions on Venus and Mars. E. B. Armstrong has a paper with the title "Geometrical Optics, and the Schmidt Camera", which summarizes the progress in optics during the nineteenth century and then deals with a description of the Schmidt camera and with some of its ramifications. "News and Comments" covers a number of notes by Dr. Öpik on various current topics discussed in different astronomical publications, and there follows the usual "Queries and Answers". Dr. E. J. Öpik, the editor of this new publication, must be congratulated on the excellent standard of its contributions, and we wish it success in the future.

Films of Parasites of Man and Animals

The medical committee of the International Scientific Film Association has issued a preliminary list of films on human and comparative parasitology which contains information received in response to a circular sent out last March. The list includes films made in Great Britain, France, Belgium, Switzerland, Norway, Denmark, Germany, Italy, Yugoslavia, Portugal, the United States, Canada, Australia, Brazil, Uruguay, Rhodesia and the U.S.S.R. The Protozoa are represented by films of *Trypanosoma gambiense* and sleeping sickness, *Shizotrypanum cruzi* and the disease it causes in South America (Chagas's disease), *Entamœba histolytica* and amœbic dysentery, malaria and its control in Sardinia and in general, and *Lankesterella* (listed as a Hæmogregarine) and *Balantidium coli*. Flukes are represented by *Opisthorchis felineus*, *Schistosoma*, *Fasciola hepatica* and some other species. Tapeworms appear in films of the development of the human fish-tapeworm (*Diphyllobothrium latum*) and of hydatid cysts of the lung, and in one on the operation for the removal of hydatid cysts. The roundworms filmed are *Strongyloides*, hookworms, *Loa loa*, *Trichinella*, *Ascaris*, stomachworms of sheep, the human threadworm and filarial worms. Films on insects include the housefly and the blowfly, the control of these, and mosquitoes, and there is one on the biology of the tsetse fly, *Glossina palpalis*. Other insects filmed are the bed-bug, human lice (which also appear in films dealing with the control of typhus in Naples and elsewhere) and the Congo, and the floor maggot of *Auchmeromyia*. Arachnids are represented by *Sarcoptes scabiei* and the ticks concerned in the transmission of Rocky Mountain spotted fever, which appear in a film on the preparation of a vaccine against this fever. Other subjects dealt with are the technique of making blood films, the diagnosis of human threadworm infection, the development of the chick embryo, *Treponema pallidum*, syphilis, and avian and other spirochætes. There are also films on dengue fever, the control of plague, the locomotor apparatus of bacteria and tissue culture. The committee hopes to receive additions to this preliminary list and corrections of it, so that it may compile a permanent catalogue and may issue periodical supplements to it. The address of the committee is 231 Péristyle Montpensier, Paris, 1, and the letter accompanying the list comes from Dr. Willem de Vogel, c/o Universitaire Film, Catharijnesingel 59, Utrecht.

Bird-migration across England

Observations by Eric Simms in 1948 and 1949 indicate the existence of an overland migration route across the South Midlands of England during the autumn months (*British Birds*, **43**, No. 8; August 1950). The route runs in a south-westerly direction across Preston-on-Stour, near Stratford-on-Avon. In both years the peak of migration took place about the middle of October, the birds recorded including flocks of skylarks, meadow-pipits, wagtails, mixed flocks of finches and yellowhammers, redwings, geese, snipe, gulls and swifts; the commonest species in both years were skylarks, meadow-pipits and chaffinches. Most migration was seen during the second hour after dawn, although movement was sometimes observed earlier. Meadow-pipits often migrated right through the day. Although migration was noticed specially on clear, fine days, it still took place in some rain and in gusty weather; temperature appeared to have little or no effect. Most birds seen on the route were 50–300 ft. above the ground. This, and evidence from other observers, suggests the possibility of a migratory bird route across England from the Wash to the Severn; but much research remains to be done before this can be accepted.

Avian Systematics

A two-day course in "Avian Systematics", arranged by the Liverpool City Museums in conjunction with the British Trust for Ornithology, was held in Liverpool during December 29–30. Mr. J. H. Iliffe (director, Liverpool Museums) opened the course with an address of welcome, after which the first lecture by Mr. W. K. Ford (Liverpool Museums) dealt with systematic zoology in general. Mr. R. Wagstaffe (Liverpool Museums) followed with an introductory lecture on avian systematics. Sub-

sequent lectures on "The Warblers" by Mr. Wagstaffe and "The Yellow Wagtails" by Captain C. Grant (British Museum) dealt in detail with the classification of these groups of birds. Practical work was not neglected and Mr. Wagstaffe demonstrated the making of cabinet skins for study purposes and the preparation of bird lice for microscopical examination. An extensive series of specimens from the Liverpool and British Museums' collections illustrated some of the more critical races of British birds, and changes in colour in cabinet skins.

On the evening of December 29, Mr. W. B. Alexander (chairman, Bird Observatories Committee of the British Trust for Ornithology) gave a talk on "Bird Observatories". The next evening was spent in the City Library, where a special exhibition of rare and historical works on birds had been arranged. This included the four elephant folios on "The Birds of America" by J. J. Audubon. Mr. A. K. Wiffen (Liverpool College of Art) gave a lecture on methods of illustration and colour reproduction. Finally, on December 31 a party of the younger members braved severe weather in an excursion to Hilbre Island, where birds of thirty-five species were seen.

British Plastics Exhibition and Convention

A British Plastics Exhibition and Convention will be held in Olympia, London, W.14, during June 6–16. The Exhibition is being organized, with the approval and co-operation of the British Plastics Federation, by *British Plastics*. Arrangements for the Convention are being made by a committee on which are represented the Federation, the Plastics Institute and the Plastics and Polymer Group of the Society of Chemical Industry. A special feature of general public interest will be the exhibit of the properties and applications of plastics, entitled "The Story of Plastics", which is being sponsored jointly by the organizers, the British Plastics Federation and the Council of Industrial Design. Subjects for discussion at the fifteen sessions of the Convention have been arranged. Morning sessions, from which the public will be excluded, will be devoted to scientific and technical papers on subjects such as progress in materials, developments in plant and equipment and fabrication techniques. In the afternoons there will be papers of a more general kind, dealing with various applications of plastics—in the chemical and textile industries, in building and architecture, in transport and in packaging, and a 'housewives' quiz'. Films will be shown every evening except Saturdays.

Forthcoming Chemical Meetings in the United States

A number of meetings relating to chemistry will be held in the United States during September on the following dates: 3–7, in New York, meeting of the American Chemical Society; 8–9, in New York, meetings of the executive committee of the council and commissions of the International Union of Pure and Applied Chemistry; 10–13, in New York, Twelfth International Congress of Pure and Applied Chemistry; 14–15 (and, if necessary, 16), in Washington, D.C., continuation of the International Congress; and, on September 14, the celebration of the fiftieth anniversary of the National Bureau of Standards. The headquarters for these events will be the Hotel Statler, New York, and the organizing secretary is Dr. Harry L. Fisher, National Research Council, 2101 Constitution Avenue, Washington 25, D.C. Two copies of the titles and abstracts (400 words maximum, in English) of all papers must reach Dr. Fisher by March 1, and the closing date for the complete manuscripts is May 1; the papers may be in English or French, but English is preferable. To help British chemists who may wish to take part in the International Congress, the Royal Society British National Committee for Chemistry has set up a sub-committee consisting of Sir David Brunt, Dr. L. H. Lampitt and Dr. D. C. Martin, the assistant secretary of the Royal Society. All inquiries should be addressed to Dr. Martin at the Royal Society, Burlington House, London, W.1.

American Societies for Experimental Biology

The thirty-fifth annual meeting of the Federation of American Societies for Experimental Biology will be held in Cleveland, Ohio, during April 29–May 3. The headquarters hotels will be the Statler, for the American Physiological Society, the American Society for Pharmacology and Experimental Therapeutics and the American Society for Experimental Pathology; and the Cleveland, for the American Society for Biological Chemists, the American Institute of Nutrition and the American Association of Immunologists. Information on hotels can be obtained from the secretary of any one of the constituent Societies or from Dr. M. O. Lee, Federation Secretary, 2101 Constitution Avenue, Washington 25, D.C. All inquiries referring to exhibits by members and by industrial laboratories should be sent to Mr. Steven K. Herlitz, 280 Madison Avenue, New York 16, N.Y. An office of the Federation Placement Service will be maintained during the meetings for the convenience of applicants for positions and employers, and forms relating to this, to be completed by April 15, can be obtained from the Placement Service, 2101 Constitution Avenue, Washington, D.C.

Announcements

Prof. J. B. Speakman, professor of textile industries in the University of Leeds, has been awarded the honorary fellowship of the Textile Institute—the highest honour within the Institute's gift—in recognition of his outstanding contributions to the chemistry and physics of wool fibres and protein fibres generally. There have been only nine previous awards of honorary fellowships since their institution in 1928.

The Royal Aeronautical Society is offering the following scholarships for students: Royal Aeronautical Society Charter Scholarship(s), of value up to £300 a year; and Geoffrey De Havilland Memorial Scholarship(s), of value approximately up to £120. Both awards are initially for one year, with possible extension for another year. Applications should be completed before June 1 and sent to the Secretary of the Society at 4 Hamilton Place, London, W.1.

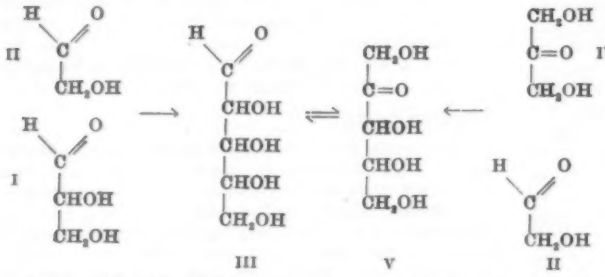
The Royal Society of Arts is offering a prize of £500 and a gold medal as part of the Society's celebrations of the Great Exhibition of 1851, for the best means of promoting the production or the economic utilization of food in Britain. The judges will be Sir Frank Smith (chairman), Prof. E. N. da C. Andrade, Sir John Russell, Sir James Turner (president, National Farmers' Union) and a nominee of the president of the Royal Agricultural Society of England. The closing date for the competition is March 1.

BIOSYNTHESIS OF THE MONOSACCHARIDES

By L. HOUGH and J. K. N. JONES
Department of Chemistry, University of Bristol

THE photosynthetic process whereby the carbohydrates are formed in the living plant cell from carbon dioxide and water was recognized as early as 1840, yet, despite intensive investigation, the intricate mechanism of this apparently simple process remains ill-defined. While there is little doubt that the hexose sugars D-glucose and D-fructose arise from the aldol condensation of dihydroxyacetone and D-glyceraldehyde[1], as their phosphates, the origin of the pentose sugars is obscure. The significance of the occurrence of the pentose sugars in Nature has been reviewed by Hirst[2], who, in an attempt to find an answer to the problem of their origin, has investigated, with his collaborators, the pectic substances, the plant gums and the plant mucilages, which contain a variety of pentose, hexose and uronic acid residues. It is clear that if the pentoses are derived from polysaccharides containing hexose residues, then the polysaccharides must first be degraded to the monosaccharides, after which conversion of hexose to pentose may occur[3].

It has been suggested that the pentoses may originate from the decarboxylation of the hexuronic acids, the polymerization of formaldehyde, or the aldol condensation of glyceraldehyde and glycollic aldehyde[3,4]. There is no evidence that pentoses arise directly from the hexuronic acids by decarboxylation; in fact, the little evidence available is, on the balance, to the contrary[5].



In these and the following formulæ the configuration of the sugars is not implied

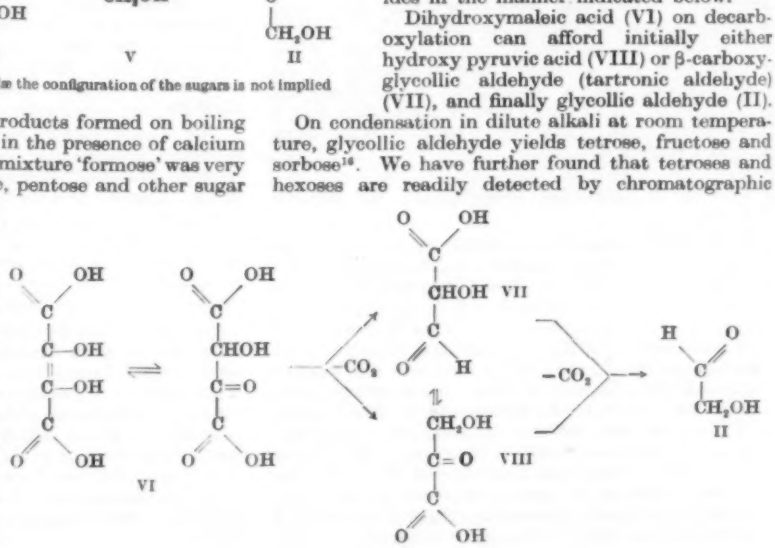
An examination of the products formed on boiling a solution of formaldehyde in the presence of calcium carbonate revealed that the mixture 'formose' was very complex, containing hexose, pentose and other sugar derivatives[6]. On the other hand, we have found that the condensation of D-glyceraldehyde (I) with glycollic aldehyde (II) in alkaline media at room temperature affords a relatively simple mixture in which all four pentose sugars (III), namely, lyxose, ribose, xylose and arabinose, can be detected, the latter two predominating. This is a result of particular interest in connexion with the biogenetic origin of the pentose sugars. Racemization of the D-glyceraldehyde occurs during the reaction and, as a result, the DL- as well as the D-pentose sugars are produced.

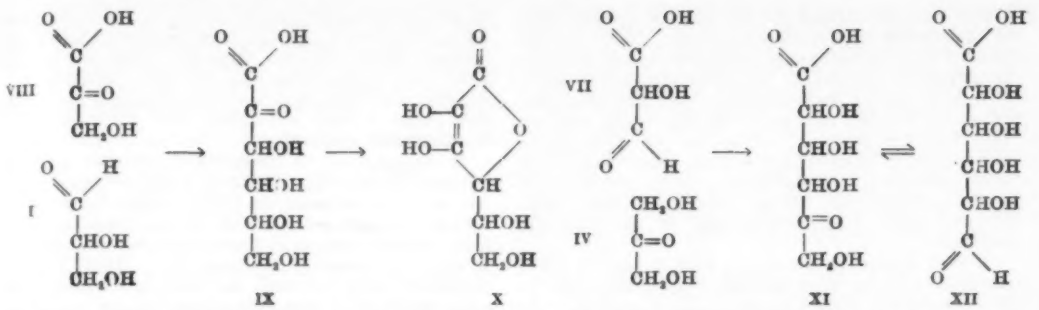
The sugars were separated by paper partition chromatography[7] and identified on the paper chromatogram from their rate of movement[8] and from the colours produced on reaction with a variety of specific spray reagents[9]. The sugars were then separated on a column of cellulose[10], and DL-arabinose was conclusively identified as the characteristic DL-benzoylhydrazone derivative from which the crystalline DL-sugar was prepared. DL-Xylose was characterized as its crystalline *p*-toluene sulphonylhydrazone. We have also observed that dihydroxyacetone (IV) undergoes condensation with glycollic aldehyde (II) to yield the aldopentoses. Orthner and Gerisch[3] detected the ketopentoses (V) in a similar reaction, and Euler and Euler[11] identified arabinose in the condensation products of formaldehyde. Zymohexase will catalyse the reversible condensation of dihydroxyacetone phosphate with glycollic aldehyde[12] and acetaldehyde to give a ketopentose 1-phosphate and a 5-deoxy-ketopentose 1-phosphate respectively[13]. This is, therefore, strong evidence in favour of the suggestion that pentoses arise from the condensation of a diose with a triose.

Calvin[14], as a result of a unique investigation of the photosynthesis process using radioactive carbon dioxide, has proposed a four-carbon cycle utilizing, as one of the components, dihydroxymaleic acid (VI). Since glycollic aldehyde (II) is readily prepared from dihydroxymaleic acid (VI) by decarboxylation[15] under very mild conditions, it occurred to us that the latter (VI) may be an important intermediate in the biosynthesis of the sugars and, in particular, the uronic acids and vitamin C. It is possible to account for the biosynthesis of the natural monosaccharides in the manner indicated below.

Dihydroxymaleic acid (VI) on decarboxylation can afford initially either hydroxy pyruvic acid (VIII) or β-carboxyglycollic aldehyde (tartronic aldehyde) (VII), and finally glycollic aldehyde (II).

On condensation in dilute alkali at room temperature, glycollic aldehyde yields tetrose, fructose and sorbose[16]. We have further found that tetroses and hexoses are readily detected by chromatographic





IX X XI XII

analysis of the mixture produced on condensation of glycollic aldehyde with baryta. Tetroses are highly reactive since they cannot possess a pyranose ring structure, and they exist to a large extent as the aldehydo form in solution. On reduction they yield tetritols; mesoerythritol occurs in lichens[17], algæ[18], and grasses[19].

Condensation of β-hydroxy pyruvic acid (VIII) with glyceraldehyde (I) could yield 2-ketohexonic acid (IX). It is noteworthy that 2-keto D-gluconic acid occurs in Irish moss[20] and that 2-keto L-gluconic acid is readily converted[21] into vitamin C (X). 2-Keto D-gluconic acid can, however, be produced from D-glucose by dehydrogenation *via* D-gluconic acid (see above). On the other hand, β-carboxy glycollic aldehyde (tartronic aldehyde) (VII) would be expected to condense with dihydroxy acetone to yield a 5-keto hexonic acid (XI), which by epimerization would form a hexuronic acid (XII) as suggested by H. O. L. Fischer, E. Baer and H. Nidecker[22]. It is perhaps significant that the uronic acid derivatives, vitamin C and tartaric acid (a possible precursor of dihydroxy maleic acid) commonly occur together in the plant kingdom. Fenton[23] has shown that tartaric acid is oxidized by atmospheric oxygen in the presence of a ferrous salt to dihydroxy maleic acid (cf., however, E. H. Mosbach and C. G. King[23a] and S. S. Jackel *et al.*[23b]).

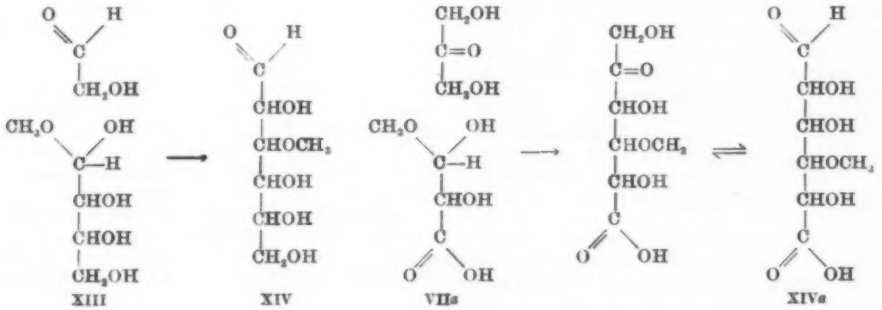
Any general explanation of the biosynthesis of the sugars must clearly account for heptoses, deoxy sugars, methyl sugars and branched-chain sugars. The naturally occurring heptoses could originate from the condensation of D-erythrose with dihydroxy acetone, in a similar fashion to the pentose sugars. Mr. K. B. Taylor, working with us, has observed that D-erythrose and dihydroxyacetone on condensation in alkaline solution give a product which on the paper chromatogram behaves as a heptulose and shows the same colour reaction. We are now attempting the isolation of this sugar with the view of its conclusive identification.

The 2-deoxy pentoses may arise in a similar manner from acetaldehyde[24] and glyceraldehyde, the 2 : 6-dideoxy hexoses from 2 molecules of acetaldehyde (which can arise from oxalacetic acid or pyruvic acid) and 1 molecule of glycollic aldehyde, that is, from 4-deoxy tetroses and acetaldehyde, and the 6-deoxy hexoses from 3-deoxy glyceraldehyde (lactic aldehyde) and dihydroxyacetone or 4-deoxytetrose and glycollic aldehyde. It is significant that the methyl ether derivatives of the neutral sugars that are known to occur in Nature are all of the 3-methyl type[25,26], and in order to account for their synthesis we postulate the condensation of the methyl hemi-acetal derivative of an aldehyde with glycollic aldehyde; for example, the methyl hemi-acetal of a tetrose (XIII) would yield 3-methyl hexose (XIV). The reaction may proceed *via* the 1-phosphate derivative of the methyl hemi-acetal (cf. glyceraldehyde 1 : 3-diphosphate in the alcoholic fermentation cycle). Methyl pectate occurs in most plant tissues, and may act as a reserve of methyl alcohol (see below).

Similarly, 3-methyl-2 : 6-dideoxyhexoses, which occur in the cardiac glycosides[18], may arise from the methyl hemi-acetal of 4-deoxy tetrose and acetaldehyde. Using the mechanism postulated previously for the synthesis of the uronic acids, the 4-monomethyl derivative would arise from the condensation of the methyl hemi-acetal of β-carboxy glycollic aldehyde (VII*a*) and dihydroxyacetone. It is precisely this isomer (XIV*a*) which has been encountered by White[27], who has identified 4-methyl D-glucuronic acid among the hydrolysis products of mesquite gum.

Apiose (XV), hamamelose (XVI) and streptose (XVII) are the only branched-chain sugars known to occur in Nature; their biosynthesis may be considered as resulting from condensation of dihydroxyacetone with glycollic aldehyde, glyceraldehyde with itself and tartardialdehyde with acetaldehyde respectively (see p. 182).

The argument is substantiated by the experiments of Ness, Hann and Hudson[28] and of Utkin[29]. The



XIII XIV VII*a* XIV*a*

former authors carried out an internal condensation of methylene-*bis*-2-D-glyceraldehyde (XVIII) and isolated a monomethylene derivative which is of the hamamelose type (XIX). Utkin isolated a homologue of apiose termed dendroketose (XX) from the condensation of two molecules of dihydroxy acetone. The 2-amino hexoses, which are of such major importance in animal metabolism, may conceivably arise from the condensation of a tetrose and N-acetyl amino-acetaldehyde. It is perhaps significant that penaldic acid (XXI) forms part of the penicillin molecule.

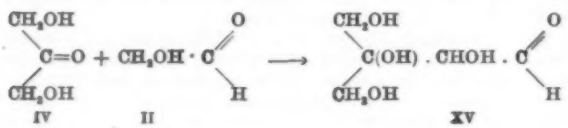
It is of interest in connexion with the origin of the pentoses to note that glucose 6-phosphate can be oxidized by the agency of an enzyme present in yeast or red blood cells to 6-phospho-gluconic acid and then proceed further to a pentose phosphoric ester[20,21]. Cohen and McNair Scott[20] were able to identify 2-keto gluconic acid, ribose 5-phosphate and glyceraldehyde 3-phosphate in the enzymic oxidation products of 6-phospho gluconic acid, by the use of paper chromatography. For a ribose derivative to be formed from 2-keto gluconic acid, transformation must have occurred. The detection of glyceraldehyde 3-phosphate suggests that 2-keto gluconic acid may be split into glyceraldehyde and hydroxy pyruvic acid (VIII), which then loses carbon dioxide to give glycollic aldehyde, which on recombination with glyceraldehyde could yield ribose. C. Neuberg and J. Kerb[22] have shown that yeast contains an enzyme capable of decarboxylating (VIII). It is worth noting that D-ribose-5-phosphate is an intermediate product in the conversion of glucose to ribose. This phosphate can exist in a furanose form only, and it is this form which is found in the nucleic acids (*cf.* fructose, which readily forms a 1 : 6-fructofuranose diphosphate, and always occurs as the furanose form in natural products). L-Arabinose has only been encountered in the furanose form, and it is tempting to suggest that this sugar is also converted into polymers *via* a 5-substituted derivative.

It remains to be determined whether L-glyceraldehyde or glycollic aldehyde is the precursor of the hexose and pentose sugars of the L-series, for example, L-galactose, which occurs in linseed mucilage[23] and snail galactogen[24], and L-arabinose, a common constituent of plant polysaccharides. It is perhaps significant that L-sorbose has been synthesized from L-glyceraldehyde and dihydroxy acetone phosphate using zymohexase[19].

While the scheme above receives support from several experimental observations, the syntheses may not follow such a simple course in the living cell, although it is significant that a number of these reactions have been performed under extremely mild conditions reminiscent of those that occur in Nature. Almost certainly the reactions proceed *via* the energy-rich phosphate esters under the influence of specific enzyme systems, but only when these systems have been isolated will it be feasible to draw rigid conclusions.

It is hoped that the above suggestions will stimulate interest in glycollic aldehyde as a possible precursor of sugars (*cf.* Z. Dische[25]). [Aug. 4.

Note added in proof. Since this article was submitted for publication we have isolated the *p*-toluenesulphonylhydrazone of DL-xylose from 'formose', and crystalline DL-sorbose from the products of polymerization of glycollic aldehyde. Crystalline DL-arabinose and a crystalline derivative of DL-xylose have also been isolated from the condensation of glycollic aldehyde and dihydroxyacetone.



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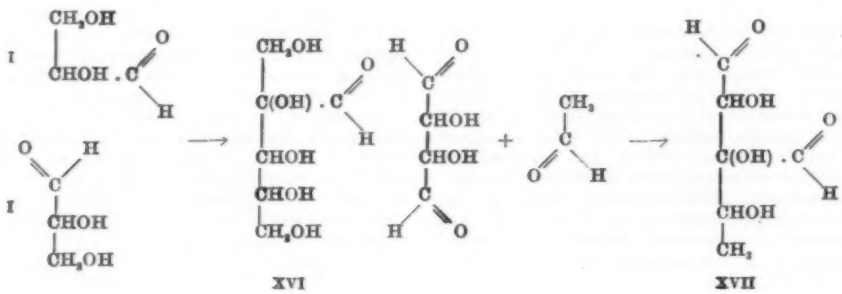
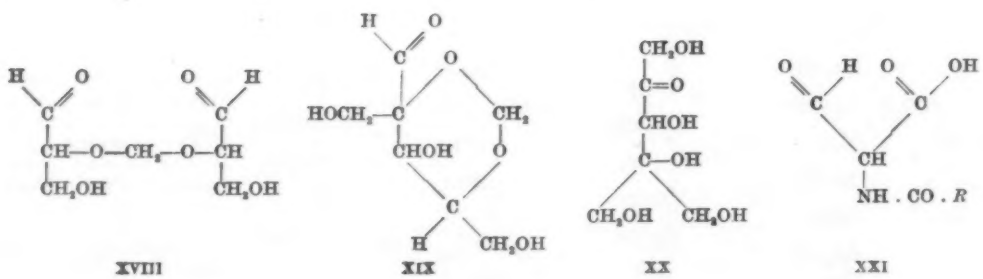


XVI XVII



XVIII XIX XX XXI

The identification of 5-methylthio-5-deoxypentose[34] in natural products is of great interest. It might arise from S-methyl cysteine by oxidation to the aldehyde, followed by its condensation with dihydroxyacetone. Similarly, glycollic aldehyde might arise from serine and D-lactaldehyde from L-threonine. [Dec. 14.

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REPTILIAN RETINAS

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PRIOR to the publication by Walls[1] of the results of an extensive survey of the reptilian retina, knowledge of the retina of this class was very inadequate and in part inaccurate. Walls studied more than a hundred species "carefully selected so as to represent as many taxonomic and habit categories as possible". These and some further results were summarized in his book on the vertebrate eye[2]. Thanks to this work we now have a very good knowledge of the principal visual cell patterns and evolutionary trends of the group.

I have been extending the survey. As material is still being collected, some of the more interesting results obtained to date are here briefly described.

Among the diurnal lizards the genus *Anolis* (Iguanidæ) is interesting in that, in addition to a deep central fovea, there is a somewhat shallower temporal fovea. This has been confirmed in *A. lineatopus*, *A. grahami* and *A. opalinus*. This is the first record, outside the birds, of a retina with two foveæ. The temporal fovea (seen in tangential section) definitely contains single and double cones; the visual cells in the central fovea are so slender that careful study will be necessary to be certain that doubles are absent. The employment of the central fovea monocularly and the temporal foveæ binocularly can be seen when the lizard feeds. No doubt the groove down the side of the snout in this and related genera is associated with the alignment of the temporal foveæ.

Three genera of geckos have been examined, *Aristelliger*, *Gonatodes* and *Sphærodactylus*. As has been described for other geckos, the single and double visual cells are in horizontal rows, a row of singles alternating with a row of doubles. It has been noted that in a row of doubles the chief member lies alternately above and below the accessory member. They are remarkable in that, in addition to the usual lacertilian single (type *A*) and double (type *B*) visual cells, they have a new and unique type of double cell (type *C*). It consists of two approximately cylindrical elements of unequal diameter lying side by side. Both possess a paraboloid (in *S. parkeri* the paraboloid of the smaller member is sometimes lacking) and an ellipsoid. Where the ordinary singles have an oil droplet the larger member of the type *C* doubles also has one. They occur scattered in among the rows of singles; they show no regular orientation. On the nasal side of the retina of *Aristelliger præsignis* there were, in whole numbers, 50 per cent type *B*, 30 per cent type *A* and 20 per cent type *C* visual cells, so they are clearly not an occasional abnormality as are, for example, the two or three triple cells which have been encountered.

Walls postulated that the single and double oil-droplet-free rods of the retina of such geckos as *Hemidactylus*, *Coleonyx* and *Gekko* are derived from typical lacertilian single and double droplet-bearing cones by transmutation (ref. 2, see Fig. 25). *Aristelliger præsignis* has rods with stout outer segments and colourless oil droplets in the singles and both types of doubles; it has the typical gecko pupil which closes to a vertical slit (but does not have the serrated pupil margin of such forms as *Hemidactylus* and *Tarentola*). This virtually proves Walls's theory that gecko rods have originated from droplet-bearing cones.

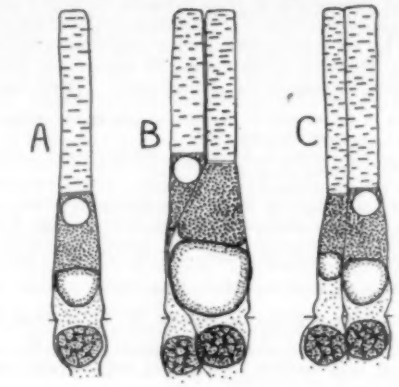
Gonatodes fuscus, *Sphærodactylus argus* and *S. parkeri* have a temporal fovea—the only authentic instances of a fovea in geckos. *Gonatodes* has a pupil which closes to a broad vertical oval, it has a pure cone retina, the type *B* doubles have a droplet, the singles and type *C* doubles are droplet-free. The oil droplet is very pale yellow in colour. *S. argus* has a pupil which closes to a slightly narrower and more pointed oval, it has droplet-free visual cells which are intermediate in proportions between rods and cones. *S. parkeri* has a pupil which closes to a vertical slit and a pure rod retina. The droplet-free visual cells have stout outer segments which are somewhat shorter than those of *Coleonyx* as figured by Walls. It is thus the only known animal with a fovea in a pure-rod retina. These forms have yet to be examined for rhodopsin.

Walls[2,3], on the basis of his eye studies, postulated that the snakes are of burrowing origin. To explain the numerous peculiarities of the snake eye he

suggested that in the snake ancestors the eye underwent wholesale reduction and simplification in association with fossorial habits and that afterwards there was re-elaboration of the eye with a return to above-ground habits. The eyes of burrowing reptiles naturally acquired a new interest. *Anniella* was the only burrowing form examined by Walls himself. A number of other forms have been examined by various workers, but nearly all of them used poorly fixed material, and accounts of the visual cells are worth very little. Some of them mistook very recent degeneration due to inadequate fixation for phylogenetic degeneration. Several forms have been studied by me with good material. The contrast between the eye of *Amphisbæna fuliginosa* (received through the kindness of Dr. E. McC. Callan) on one hand and *Leptotyphlops humilis* (received through the kindness of Dr. G. L. Walls) and *Typhlops jamaicensis* on the other is instructive. The retina of *Amphisbæna* has small undifferentiated elements with oil droplet and paraboloid which resemble embryonic visual cells[4]. *Leptotyphlops* and *Typhlops*, on the other hand, have small but fully differentiated single visual cells which are interpreted as rods on account of their fairly large outer segments and their close packing with consequent piling up of the outer nuclei in two or three rows. They lack oil droplet and paraboloid, and resemble the visual cells of the Boidæ. *Amphisbæna* retains scleral cartilage but has no eye muscles: the lens is of irregularly arranged cells. The two burrowing snakes have a purely fibrous sclera, striated eye muscles and a well-formed lens with regularly arranged fibres and a thin capsule. This suggests that the eye of *Amphisbæna* is undergoing regression with loss of visual function, whereas the eyes of the two burrowing snakes may be said rather to have undergone adaptive reduction and simplification without loss of control of ontogenetic differentiation. Such a snake eye could be imagined as capable of re-elaboration in the manner required by Walls's hypothesis. Although the eyes of these two forms are too far reduced to represent the condition of the ancestral snake eye, they show that the snake eye has become modified in relation to a fossorial habit in a manner strikingly different from that of known lizards. It is hoped to obtain material for study of the eye of the snake family Anilidæ. It may be suggested that the snake ancestors were nocturnal before they were fossorial, thus losing the oil droplets, paraboloids and double cells. The only family of lizards which shows this combination of nocturnal and fossorial habits is the Pygopodidæ. Material of the more thoroughly fossorial members of this family has not as yet been obtained.

Camp[5] divides the lizards into two groups: the Ascalabota and Autarchoglossa. He points out that the Ascalabota show a strong tendency towards an arboreal habit and no tendency towards reduction of the limbs. On the other hand, the Autarchoglossa show relatively slight arboreal tendencies, but a pronounced tendency towards reduction of the limbs. In fact, six families are limbless and four more families include forms with limbs greatly reduced or wanting. It may be pointed out that the Ascalabota are sight feeders and as such seem to be relatively little dependent on Jacobson's organ in the finding of food. If an ascalabotid tends towards secretive habits it must therefore lower the threshold of its retina if it is to be able to continue to feed in secluded situations; this leads ultimately to the transmutation

Fig. 1. Visual cell types of *Aristelliger praesignis*. × 1,000



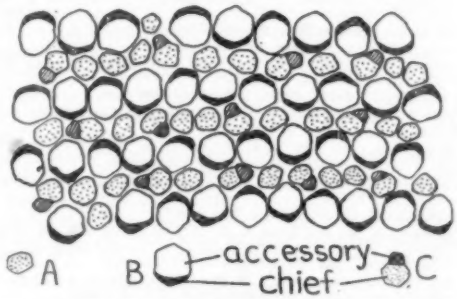


Fig. 2. A portion of the retina of *A. praesignis* in tangential section at the level of the paraboloids (semi-diagrammatic)

of an all-cone retina into an all-rod retina, and this is precisely what we see in geckos. On the other hand, the Autarchoglossa show a strong tendency for smell to supersede sight as the important sense in food-finding, with corresponding elaboration of Jacobson's organ. Speaking generally, autarchoglossids which tend towards secretive habits rely more than ever on the sense of smell, with consequent further reduction in the relative importance of the eye. Thus we see following a dwindling in the size of the eye an actual regression of the process of ontogenetic differentiation. The pygopodids and the snakes are perhaps exceptions to this generalization. [July 20.

Addendum. Through the kindness of several persons in other parts of the world, I have received material of six more species of geckos. Type *C* double cells have been found in all these forms; they are *Coleonyx v. variegatus*, *Phyllodactylus t. tuberculosus*, *Gehyra mutilata* (from Mr. C. B. Perkins, California), *Hoplodactylus pacificus* (from Dr. N. G. Stephenson, New Zealand), *Hemidactylus bowringi* and *Gekko chinensis* (from Mr. J. D. Romer, Hong Kong). In geckos which have droplet-free rods, the type *C* doubles are not very obvious unless tangential sections be examined; this, no doubt, explains why they have been overlooked hitherto. Their true and distinct nature is most clearly seen in *Aristelliger*, because it retains a full complement of oil-droplets.

Prince[6], in his recent book, gives a photomicrograph of a tangential section of the retina of the pygopodid lizard *Lialis burtoni*. The resemblance to a tangential section of a gecko retina is striking. The single and double elements are in alternate horizontal

rows; it cannot be seen in his figure whether there is an alternation of the orientation of the double elements or whether the rows of singles include any type *C* members. If, on further investigation, the pygopodid retina proves to agree with the gecko retina in these details, this would constitute strong evidence in favour of the view that these two families are related, a view which is supported by some osteological evidence.

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THE GOLGI APPARATUS OF LIVER AND NERVE CELLS

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THE article by Dr. Geoffrey H. Bourne in *Nature* of September 30, 1950, is the second which has been published in recent months (see J. Baker, *Nature* of April 1, 1950) in which it is stated that past work on the Golgi apparatus can be re-interpreted on the findings of Palade and Claude[1].

Bourne refers especially to the supposed presence of granules of vitamin in cells of the suprarenal. In previous attempts in this laboratory, neither I myself nor research students could confirm satisfactorily Bourne's results with the acetic acid–silver nitrate method, which is very capricious. I was prepared to believe that such mainly negative results were due to some personal factor, and was content to leave matters as they stood, trusting that in one somatic cell at least a biochemical connexion between the Golgi apparatus and such a substance as a vitamin had been established. In his most recent communication, Bourne replies to those who have suggested that the vitamin is diffused throughout the cell, and uses the work of Palade and Claude to support his views. Bourne suggests that the true 'Golgi element' (Golgi apparatus) of the cortical cells may be represented by a series of vacuoles, probably phospholipid in nature. I have not yet made a special study of the cortical cells of the suprarenal, but I am prepared to express an opinion on Palade and Claude's work on the hepatic cell, which I have recently studied in this laboratory with T. Moussa, and which forms the main part of Palade and Claude's results.

The adult normal rat liver has cells as in Fig. 1, the bile region on the right, with characteristic flexuose tubules (*GA*) opening through a terminal thickening in the cell wall (*V*), to the external bile canaliculus (*B*). On the left of the cell are most of the fat globules lying on that side abutting against the blood sinus (*LC*). Neither mitochondria nor glycogen vacuoles have been added to the diagram, but most of these structures mentioned can be seen in the living cell with the phase-contrast microscope. No cytologist has described a juxta-nuclear Golgi apparatus in normal adult liver cells. The fat is oily, and in fresh crushes of liver can be distorted easily by pressing the cover-slip. If these peculiar zig-zag canals are the Golgi apparatus, and the group of oil globules not the Golgi apparatus, how then does this canalicular system arise? The answer will be found in a paper by A. J. Dalton[2], who worked at Harvard under Alden B. Dawson. Dalton examined nearly a hundred chick livers at different incubation ages of development. Three of his figures are reproduced here. In Fig. 2, of a four incubation-day chick liver, the Golgi apparatus is subspherical and is already oriented towards the region where the external bile canaliculus will appear. In Figs. 3 and 4, of seven- and fourteen-incubation day chicks, the external bile canaliculus has appeared, and the Golgi apparatus filaments have loosened out to form the characteristic zig-zag or flexuose apparatus which lies towards the external bile canaliculus. Dalton figures both cholesterol and fat globules as in Fig. 4. In the words of E. D. P. de Robertis[3], who studied the toad liver, "El aparato de Golgi ocupa el polo biliar de la célula disponiendose en forma de un cordón flexuoso que emite algunos cortas prolongaciones hacia el centro de la célula". The work of Dalton is important, for it is the complete and final answer to that largest part of the Palade–Claude mash cytology which deals with the liver.

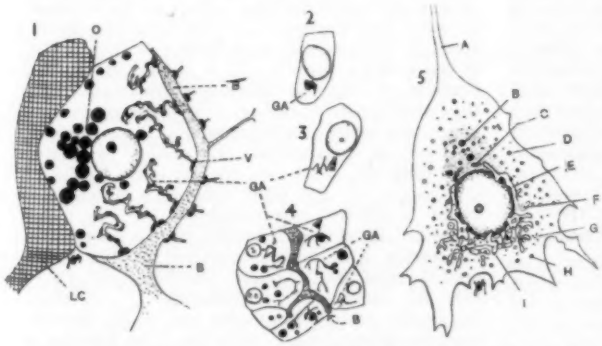

Fig. 1. Hepatic cell (Aoyama and Sudan). *O*, oil droplets; *B*, bile duct; *GA*, flexuose intracellular bile ducts formed from Golgi apparatus; *V*, valve on cell wall

Figs. 2–4. Embryonic development of flexuose canals from subspherical discrete Golgi apparatus (after Dalton)

Fig. 5. Sympathetic neurone of young rabbit showing secretion pigment (*I*, *F*) appearing in Golgi canals *E*, and passing forwards to axon end *B*, *C*. *D*, Ciaccio fat vesicles (Baker's bodies). *G*, mitochondria. Lison preparation, formalin and Sudan black, in which the Golgi apparatus appears as canals

Passing now to the mammalian sympathetic neurone worked upon by J. R. Baker[4] and Owen Thomas[5], peculiar subspherical vesicles are described, which have been identified by them in their recent papers in the *Quarterly Journal of Microscopical Science* as "mulberry spheroids", "Baker's bodies", "spheroidal complexes", "spheroids", etc. According to Baker, these constitute the Golgi apparatus, which, however, is believed by Thomas to be formed of an artificial tangle of elongate mitochondria with "Baker's bodies". Afterwards Moussa and I[6] pointed out that Ciaccio[7] had described such bodies so far back as 1910. After further consideration, Baker now indicates that such bodies are neither Baker nor Ciaccio bodies, but the "lipochondria" of Schneider[8]. Turning to G. Hirsch's[9] well-known book on the Golgi apparatus, we find that "Lipochondren"

(Schneider, 1902) are "Fett enthaltende Granula", while "Lipochondrien" (Ries, 1933; I. Fischer, 1937) is a "Synonym mit Lipochondren", but also possibly identical with Hirsch's "Praesubstanzen der Golgi-Systeme". It may be asked what all these names, mostly new, have to do with the inner reticulum of Golgi in the nerve cell? The answer to this is an easy one—nothing whatever. The Golgi apparatus is a canalicular system which can be seen quite clearly in the living cells of the extirpated sympathetic ganglion of the mouse. No phase-contrast microscope is necessary; the ordinary light microscope is sufficient. Nor does the neurone fixed with formalin or osmic acid differ morphologically from the living one. A paper on this subject is being published by T. Moussa in one of the Wistar Journals. So permanent is the complicated and characteristic canalicular system of the human sympathetic ganglion cell (extirpated for hypertension) that it is impossible to destroy it by any current fixation or imbedding method. We are not sure what happens to it in tissue cultures of living sympathetic ganglia[10].

In Fig. 5 is a sympathetic ganglion cell from a half-grown mammal showing the Golgi apparatus (*EFI*) at the dendrite end, and the beginning of senility pigment at the axon end of the nucleus (*BC*). As the animal ages, the senility pigment granules collect into a compact group, well known to all students of histology. Moussa and I are of the opinion that these granules originate in the Golgi apparatus (*FI*) and move around to their definitive position in the neurone[10]. Furthermore, I now believe that these so-called senility pigment granules are, or contain, some form of neurosecretion. Their separation and biological test is being attempted. They are deeply stainable in neutral red, vitally, and serve as markers of the canalicular system in which they originate.

It will now be clear that it is not considered that the oil droplets of the liver and the so-called senility pigment granules of the vertebrate neurone are similar. In neither case do they constitute the Golgi apparatus, nor are they themselves homologous structures. These statements show how widely I differ from the views of Palade and Claude, as interpreted by J. R. Baker and Geoffrey H. Bourne.

There is just one point which is important, and stating it now may save further discussion. In his recent writing, J. R. Baker stresses the importance of examination of living cells as well as those fixed and stained. I agree fully with him in this. That is why in the British Isles, in the past, the great bulk of studies of the cytoplasm of living cells has been made by my students. It should be understood, however, that recent studies with the phase-contrast microscope merely confirm the views of Strangeways and Canti[11] on the relative values of various fixing mixtures. Osmic-containing fixatives without acetic acid or alcohol give an almost perfect fixation of the cell. Dalton used the chrome-osmium method of Nassonow–Kolatchew.

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[2] Dalton, *Anat. Rec.*, **58** (1933–34).
[3] De Robertis, *Rev. Soc. Argentina Biol.*, **14** (1938).
[4] Baker, J. R., *Quart. J. Mic. Sci.*, **85** (1944).
[5] Owen Thomas, *Quart. J. Mic. Sci.*, **89** (1948).
[6] Gatenby, Moussa and Dosekun, *La Cellule*, **53** (1949).
[7] Ciaccio, *Anat. Anz.*, **35** (1910).
[8] Schneider, "Lehrbuch der Histologie" (Jena, 1902).
[9] Hirsch, "Form- und Stoffwechsel de Golgi-Körper" (Gebrüder Borntraeger, Berlin, 1939).
[10] Murray and Stout, *Amer. J. Anat.*, **80** (1947).
[11] Strangeways and Canti, *Quart. J. Mic. Sci.*, **71** (1927–28).

TECHNOLOGICAL EDUCATION IN GREAT BRITAIN

THE case for the founding in Great Britain of one or more entirely new institutions broadly similar to the Massachusetts Institute of Technology or to the Eidgenössiche Technische Hochschule, Zurich, has of late been made in Parliament, in the technical and the serious lay Press, and in the deliberations and pronouncements of educational and scientific societies. It is a case which has not suffered from a lack of distinguished exponents, and it was therefore particularly stimulating to hear a vigorous and powerful statement of the opposing view from Lord Eustace Percy, whose attachment to the interests and needs of higher technological education is unquestionable. He was addressing the Education Group of the Institute of Physics at its meeting on October 25; many of his audience might dissent from his views, but none would have been uninfluenced by his profound and yet scintillating expression of them.

What, asked Lord Eustace, is the serious argument for a new university of technology? It is not that existing universities would be swamped by technological students if they were to attempt to meet the full needs of industry, since such students represent only 13 per cent of the total university student body, even though the number of technological degrees granted has more than doubled since 1938; nor does it stem from the mere impulse to imitate the United States or Switzerland. "No, the serious argument for a new technological university is, I take it, the one which has been advanced by certain eminent scientists: that the bias of scientific studies in the universities is towards pure research and that studies pursued with that bias cannot be expected to develop the practical interests and the executive qualities of mind which are proper to technologists. Now, the first thing to be noted about this argument is that it does not contemplate any greater specialization in technological training at the undergraduate stage. On the contrary, it is usually accompanied (with a strange lack of logic) by a demand that such training should be based, at that stage, on a much wider and deeper study of the fundamental sciences than at present. The expulsion of technologists from existing universities will, therefore, have to be accompanied by a no less wholesale exodus of professors of pure science. Nor, at any rate on the analogy of M.I.T., is there much question of a change in methods of teaching within the university institution, such as the substitution of factory-scale equipment for small laboratory units. In other words, the argument does not seem to contemplate any change in curriculum, but only the creation, in the new Technological University, of that most intangible thing in education: a different atmosphere."

But, claimed Lord Eustace, "in the past, our whole university tradition, in contrast to the university traditions of the Continent, has been one of preparation for executive responsibilities". If, therefore, university science graduates are to-day fit only for research laboratories, "it is the pure sciences which should emigrate to create new universities in their own cloistered image". "If our university tradition is in danger of decay, it is in the universities that it must be repaired and restored; industry . . . will not thank us for a policy which leaves the pure scientist to be trained in the academic atmosphere

of university honours schools, while removing the applied scientist to the more bracing climate of a technological institute."

In Lord Eustace's view, the problem of adequately developing the system of technological education in Great Britain can best be solved by carrying out experiments in existing institutions and by making an accurate appreciation of the present assets—the technical colleges and universities. Concerning the technical colleges, he said that he is now convinced (and regretted that this was not said in the report which commonly bears his name) that the necessary development and experiment cannot be hoped for so long as colleges are owned and administered by local education authorities. "A college of technology may be a State institution, like the Scottish central colleges, or it may be an independent institution like an English university college; but it cannot be administered by a municipal committee. And, in fact, the recommendations of the Percy Committee have fallen flat owing to the obstinate reluctance of the Ministry of Education and the local education authorities to do anything so 'undemocratic' as to select one institution from among others for special development, or to allow an independent governing body to spend the money of the ratepayers. So long as this continues, it is hardly too much to say that half our assets for experiment and development in higher technological education are immobilized in a blocked account."

Concerning universities, Lord Eustace claimed that many of the English provincial and the Scottish universities are achieving a natural integration of all the sciences with a bent towards their application, that such integration is the life-blood of all technologists and that existing institutions seeking such an ideal must offer more favourable ground for further experiment than any new institution serving an ill-defined ideal of segregation. Finally, many of the difficulties in the way of better technological education arise from the organization of the national industries and, in particular, from the short academic life of the engineer compared with that of any other industrial scientific worker, a fact mainly due to the apprenticeship requirements of the engineering industry and the membership conditions of some professional institutions.

The discussion on Lord Eustace's address was opened by Lord Cherwell, who felt that the universities cannot cope with the type and extent of development in technical education which is urgently needed. He quoted the technical university of Aix-la-Chappelle, which has numerous professors, full, part-time or extraordinary, giving only two or three lectures a week, and which is run at very high cost. A similar institution in Great Britain would cost about a quarter of a million pounds a year to run, and would therefore be economically feasible only if it catered for two or three thousand students. Such numbers of technological students cannot be envisaged in any existing university institution except the Imperial College of Science and Technology, London. In the past fifty years, Great Britain has lost to the United States and the Continent of Europe the great lead in technology which she had in the nineteenth century, and it is becoming increasingly difficult for British industry to compete in world markets. It is essential to provide much greater numbers of technologists.

Among other speakers, Dr. P. Dunsheath, who did not agree with Lord Cherwell's pessimistic view of the technological position, pleaded for engineers with a broad education and for facilities for men from industry to go back to college for further courses, supported by grants sufficient to maintain a family adequately.

Replying to the discussion, Lord Eustace Percy referred to the dangers of drawing analogies from the German system. It should be remembered, he said, that the German university has traditionally been almost an arts college, and that the technical university took the place of the science departments of British universities. Also, great caution should be used in drawing conclusions from the numbers of 'professors' in an institution—the significance of the title in different countries differs greatly.

N. CLARKE

MECHANIZING AFRICAN AGRICULTURE*

MR. J. W. Y. HIGGS, lecturer in agricultural machinery in the University of Reading, Mr. R. K. Kerkham, of the Department of Agriculture, Uganda, and Mr. J. R. Raeburn, reader in economics in the London School of Economics, have prepared a report as a result of a survey of African agricultural methods. They conform to their terms of reference in representing the mechanization of African agriculture as a matter for careful study and experiment. They note that data are not yet available on which to base reliable comparisons of mechanized with native systems of agriculture. For this reason the discussion impartially records both obstacles and opportunities, in statements resembling the red and green lights that permit a motorist to make his way through dense traffic.

Among the 'red lights' are the following: It is considered that savanna type of country offers the best prospects for mechanization of farming, but estimates for such an area near railhead in Northern Nigeria indicate that mechanization should be restricted to preparing the land. Even so, it is thought that farm families would not gain much by accepting mechanization, since it would be unwise to expect mechanical cultivation to produce any major increase in yields per acre. It seems that to some tenants the advantages of mechanization would be almost inconsiderable. The substitution of tractors, etc., for native labour is substitution of costly for cheap factors of production. Moreover, mechanization would make production costs less flexible. Mechanical clearing of bush is expensive and very frequently uneconomic: hand labour should clear bush whenever possible. The authors state that in many areas provision of water supplies, clinics, schools and roads should have higher priority than mechanical cultivation.

On the other hand, 'green lights' are as follows: It is noted that over most of the savannas, where possibilities of mechanization are greatest, Africans are caught in a vicious circle of malnutrition and disease, resulting in a low capacity for work. Mechanization must be one of the principal means of raising real incomes and securing better nutrition. A reasonable estimate of the labour required to open

* Colonial Office: Colonial Advisory Council of Agriculture, Animal Health and Forestry. Publication No. 1: Report of a Survey of Problems in the Mechanization of Native Agriculture in Tropical African Colonies. Pp. ix+124+16 plates. (London: H.M. Stationery Office, 1950.) 4s. 6d. net.

land from elephant grass in Buganda is eighty man-days per acre. One can well believe that the easy and quick performance of tasks which have previously required much toil would be regarded with favour in many areas, and, in fact, richer farmers already insist on having the use of tractors. Kerkham states that in Uganda there are large areas of uncultivated good land. It is emphasized that mechanization would facilitate the introduction of other improvements and, in view of this, there is every likelihood that both directly and indirectly mechanization would raise crop yields. Average crop yields, recorded in Appendix 2, are low. There is no reason to suppose that more than the fringe of improvements in production by agronomic methods has yet been touched. It is stated that mechanization will markedly improve opportunities for personal profit and will make possible increasing productivity and value of land. A recommendation is made that much of the increase in land values be retained by the authorities, so that revenue from the developed and richer areas may help development elsewhere.

The authors of the report do well to present these conflicting views, but in so doing they take no share of the responsibility for local decisions to speed up or slow down mechanization. It must be doubted, therefore, whether the following quotation (par. 157) can be read in isolation from the rest of the report, although it does have the appearance of a general recommendation. "The soundest policy might well be firmly to make economic development as rapid as is acceptable to the people and possible of execution, in most areas using all the opportunities offered to strengthen and give responsibilities to the existing Native Authorities and social groups."

The report includes some penetrating remarks on reactions between mechanization and the African way of life. It is wisely said that African farming systems are well worth examination. An elaborate programme of studies is outlined (pars. 287 and 337). Much can be done to secure and give support to native leadership, as is done, for example, in Northern Nigeria, where the opinions and experience of the administration, native authorities, development departments, religious missions and European and African commercial men have been brought together in a Development Committee. Reference is made to training and the presentation of a development scheme: those sequences and balances are best that win the appreciation and confidence of ordinary men and their wives.

Besides tractors and ploughs, other machines and implements are needed in Africa. The report refers to the prodigious expenditure of labour in the women's tasks of grinding flour and carrying water. Water supplies and small grain mills would result in worth-while saving of labour and would be economic at busy seasons, when the time saved would be put to better use.

The authors note that few agricultural officers have had experience in the use of machinery or of mechanized farming, for it has developed in England only during the past ten years. Training courses are suggested; in England a special machinery advisory bureau should be set up to deal with inquiries from the Colonies. The report contains some broad and rather vague recommendations such as "the variations of human population in relation to basic resources . . . require careful and comprehensive study", or "attempts should be made to discover the amount of European supervision that can be regarded as optimal under different conditions". There seems to be a misapprehension about "share" payments; in the Gezira scheme of the Anglo-Egyptian Sudan it is profits that are shared; the tenants' accounts are debited with the cost of mechanical ploughing.

Since the authors were debarred by lack of evidence from reaching firm conclusions, their report could have been more brief. On the other hand, it must be commended as an interesting and comprehensive review; it will repay careful reading.

H. Greene

SUGARCANE RESEARCH IN MAURITIUS

Mauritius, an island colony of Britain in the Indian Ocean, is still, in spite of the passage of a hundred and forty years, very attractively decorated with cultural trimmings derived from its French ancestry. The population of the island, now approaching the half-million mark, depend for their livelihood and welfare almost exclusively on a single commodity—sugar. A few other products, notably tea and fibre, offer some prospects of development as complementary crops, the former for the high-rainfall zone above the altitude limit for cane, and the latter for the drier regions and mainly for local manufacture of sugar bags. But, because of its suitability to local requirements both climatic and economic, which has been demonstrated by two centuries of experience and of plant introduction, it seems certain that sugar will continue to occupy a position of paramount importance in the Colony's economy.

Excluding the dependencies—small islands scattered about the Indian Ocean—none of which produces sugar, Mauritius is roughly 720 square miles in area and approximates in size to the County of Surrey in Great Britain. Despite its small size the island (a good illustration of the Scots proverb about 'guid gear going into small bulk') is the largest individual cane sugar producer and exporter of all the British Colonial territories, and it is estimated that the 1950 crop may produce more than 430,000 tons of sugar. If this estimate is justified in the bag, it will be the fourth record crop in succession.

The mounting curve of sugar production and the remarkable series of record crops owe a good deal to the local research and cane-breeding work which has been going on for the last twenty years. The importance of research has long been recognized—not least by the Chamber of Agriculture, a very active and progressive organization of producers which has been in existence for the past century—and this recognition found practical expression in the foundation of the Sugarcane Research Station, as a Division of the Department of Agriculture, in December 1929. For lack of other accommodation at the time of its formation, the new research institution was housed in the recently opened College of Agriculture, a 'temporary' arrangement which lasted for twenty years with increasing inconvenience to both.

In spite of housing difficulties, the Station more than justified its existence. Its most urgent initial task was to produce seedling canes to replace the old varieties, for long the mainstay of the sugar industry, which were 'running out'. The chief qualities required in the new canes were high yield capacity, good sugar content and resistance to drought, pests and diseases.

The new Sugarcane Research Station, Mauritius, showing part of the Entomological Division and Departmental Library

In this work the Station achieved what was to prove an outstanding success by producing the variety known as *M*134/32. By 1947 (the first year in the series of record crops) this remarkable general-purpose cane had replaced all other varieties to the extent of 80 per cent of the island's acreage in cane. Since then, more than 90 per cent of the cane area has been planted in *M*134/32. The variety has not only come up to requirements in regard to yield capacity, sugar content and resistance to the major pests and diseases; it has also enabled an extension of the acreage in cane by reason of its greater tolerance of climatic variation. Other good canes have been produced by the Station; but they have been overshadowed by *M*134/32, or they are adapted to special environmental conditions and are therefore grown only on a small scale. Indeed, it may be said that *M*134/32 has been embarrassingly successful for, though it still shows no sign of weakening, there is grave danger in relying on a single variety.

In some degree this success has also tended to overshadow other achievements of the Station, such as the very thorough investigation and survey of the soils of the cane belt made by the Chemical Division, and the work on foliar diagnosis. The latter, a method of determining the nutritional status of the cane plant from leaf analysis, is now applied on a commercial scale by a special laboratory financed from the Sugar Industry Reserve Fund. The work of the Division of Botany, too, has led to valuable improvements in field practice, notably in the pre-treatment of cane setts now widely adopted, and the control of weeds by means of weed-killers. Many of the more noxious weeds of cane plantations can now be controlled by selective weed-killers, and several thousand acres of infested land have already been cleared by this means.

Research will be no less necessary in the future to ensure efficiency of production in what may well be highly competitive conditions. Breeding work must go on, and one of the most urgent problems is to find successors for *M*134/32. The most probable successor for the immediate future is another product of the Station, the variety *M*423/41, which gives promise of successfully rivalling *M*134/32 and of carrying the curve of sugar production to still higher levels. Other work which is in the initial stages includes investigation of the relation between root vigour and resistance to damage by *Clemora Smithii*, the most destructive pest of cane with which the Mauritian planter has to contend, examination of the role of certain inorganic fertilizers, especially lime and magnesia, the accumulation of data to enable foliar diagnosis to be extended to these elements, and further study of some weed species for which no satisfactory control has yet been found. The Division of Botany has recently engaged in an inquiry into the vexed question of the effects of interplanting food crops with cane.

The construction of a new building for the Mauritius Sugarcane Research Station, which was formally opened by the Governor early last year and in the midst of a minor cyclone, is an indication that the importance of future research is clearly recognized even in the phase of political re-organization through which the Colony is passing.

BROWN TROUT RESEARCH IN SCOTLAND

IN February 1948 a committee was appointed by the Secretary of State for Scotland "to supervise a programme of research into the factors affecting the number, size and growth of brown trout in Scottish waters of varying types and into measures for improving the stock". This research was proposed by the North of Scotland Hydroelectric Board and the Scottish Home Department, with the support of the Scottish Tourist Board. It aims at finding out how trout fisheries in Scotland can be improved and how trout stocks can be established and maintained in the reservoirs being constructed in various parts of the country for the development of hydro-electric power.

The research is carried out under the general supervision of a committee under the chairmanship of Prof. C. M. Yonge. The headquarters laboratory is at Faskally House, near Pitlochry, in Perthshire, and the work is directed by Mr. K. A. Pyefinch, who reports on the work for the first year in a new series of Scottish Home Department Scientific Investigation Reports, Freshwater and Salmon Fisheries Research, No. 1*. A comprehensive biological survey is being made of certain selected streams and lochs of the 700 square miles of catchment area lying along the Tummel Valley and stretching from Loch Laidon through Loch Rannoch to Pitlochry, and including the River Garry and its tributaries. This area includes a variety of different types of habitat, and it is evident that the investigations may throw new light on the reasons for the great variation in growth shown by trout in different waters. Biological investigations on the trout include the tagging of large numbers and a modern method of sampling fish populations in small streams by the use of electric currents for stunning fish within a length of stream. These researches are supplemented by seasonal observations on bottom fauna and on the plankton. Marked differences have been found in the composition of the zooplankton between the larger and smaller lochs.

Preliminary investigations have been made which will prove valuable for comparison in following the biological sequence which will develop over the area which has recently been inundated to form the new reservoir at Pitlochry. F. S. RUSSELL

* Scottish Home Department. Scientific Investigations, Freshwater and Salmon Fisheries Research, No. 1: Report by the Supervisory Committee for Brown Trout Research, 1948–49. Pp. 12. (Edinburgh and London: H.M. Stationery Office, 1950.) 1s. net.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Elimination of the Unwanted Image in Diffraction Microscopy

During a discussion at Cambridge, the idea was put forward that it might be possible to eliminate the effects of the unwanted image in diffraction microscopy by taking a subsidiary hologram and subtracting it from the reconstruction. In Gabor's method[1,2] a single hologram is used, and he has shown how two images are formed, when coherent light traverses this hologram, so that the image in sharp focus has as a background a confused pattern due to the other image. In a recent note in *Nature*[3], an elementary explanation of the origin of these two images is given; the confusion they cause is the necessary price paid for the loss of information as to the phase of the disturbance in the plane in which the main hologram is taken. But in a coherent beam, if the amplitude and phase are known over a surface 1, they can be calculated over a subsequent surface 2 by Huyghens's principle. In general, the two patterns differ from one another, yet they both contain essentially the same information. This opens up the possibility that the confusion due to loss of information about *phase* in one plane, the main hologram plane, may be cleared up by measuring the *amplitude* in another plane which we call that of the auxiliary hologram. In other words, two suitably separated amplitude patterns will do service for a single pattern giving both amplitude and phase. While one hologram gives two images, two holograms can be made to give one image.

The position is made clearer by taking a simple case. We consider the system in which both the production and reconstruction of the hologram occurs in a parallel beam of coherent light (or electrons). This corresponds to the important practical case of the 'transmission microscope' of Haine and Dyson[4]. The arrangement is shown in Fig. 1. The main hologram H_1 (Fig. 1*a*) is taken at some arbitrary distance from the object O which we may call f, since in this special case the focal length[5] reduces simply to the object-hologram distance. If now a positive print of this hologram is placed at H_1 in Fig. 1*c*, it will form by Gabor's principle a real image I_1 of the object at a distance f. A virtual image I_2, however, is also formed at a distance f on the other side of the hologram, and we may consider the confusing background to the sharp image at I_1 as being due to the interference of light from I_2 with the main wave. In other words, the 'out-of-focus' background is the hologram of the object O at a distance $2f$. Therefore, by taking an auxiliary hologram H_2 at a distance $2f$, as in Fig. 1*b*, and placing the negative in register on the positive image I_1, we can eliminate the unwanted background. The lighter parts of H_2 fall on the darker parts of the unwanted image and vice versa, so that if the plates are suitably matched the background becomes uniform and the wanted image stands out clearly.

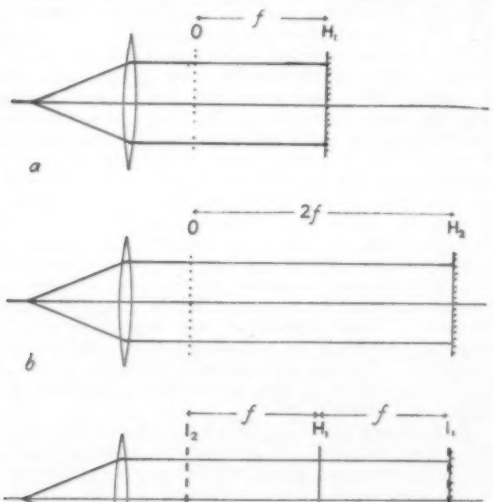

Fig. 1

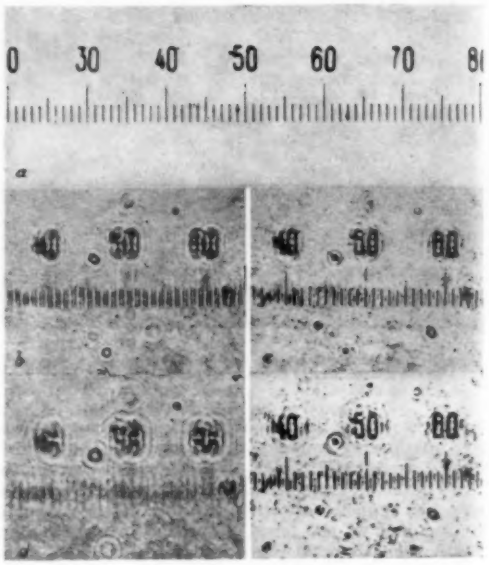

Fig. 2

An experimental test of this principle has been made in parallel light with an optical apparatus described elsewhere[6]. Though complete elimination of the background has not been obtained, the measure of success is sufficient to show that the principle works, and that an improvement in technique should yield an image practically free from the unwanted background. An illustration of the results is given in Fig. 2. Fig. 2*a* is a photograph of the object, a scale divided in 100ths of an inch. Fig. 2*b* is its main hologram H_1. Fig. 2*c* is the ordinary reconstruction of the object by Gabor's method. Fig. 2*d* is the auxiliary hologram H_2 taken at twice the distance, and by placing H_2 in register over I_1 the print shown in Fig. 2*e* is obtained. It will be noticed that the fringes around and inside the figures have almost completely disappeared, so that they stand

out with greater distinctness. The circular fringes scattered in a random way over the background are due to optical imperfections of the apparatus. When using coherent light, minute flaws or dust particles give rise to diffraction effects which are very difficult to eliminate completely.

A reduced image, about 3 microns in diameter, is formed from a 20-micron hole, and is used as the source of monochromatic coherent light (the mercury line 4358 A.). This is collimated with a 7-in. focus lens to give a parallel beam. The object, a photographic reproduction one inch in length of a scale with 100 divisions, is placed in the beam, and the plate to take the main hologram H_1 is put 11·0 cm. behind it. The auxiliary hologram H_2 is taken at 22·0 cm. distance from the object. As the beam is parallel, the projective magnification is unity throughout. The reconstruction Fig. 2*c* is made from a positive print of H_1 in the same apparatus at a distance of 11·0 cm. behind the hologram.

A corresponding procedure for the electron microscope would be to take an auxiliary hologram with twice the degree of defocusing of the main hologram.

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Ignition of Methane – Air Mixtures by Rapid Compression

Investigations into the spontaneous ignition of hydrocarbon – air mixtures by adiabatic compression are being made. It has been found that there are at least two types of ignition possible with methane – air mixtures under rapid compression.

The earlier experiments of Prettre[1], using a flow technique in a heated tube, indicated that, unlike the higher hydrocarbons, methane exhibited no distinct 'cool flame' region ; but he recorded that there was luminescence 30°–40° C. below the temperature of final ignition. The experiments of Townend and co-workers[2] indicated that under conditions when the mixture is admitted rapidly into a heated vessel there was only a single stage of ignition with methane – air mixtures up to pressures of at least 25 atmospheres. These observations have been confirmed recently up to pressures of 20 atmospheres by J. D. Broatch at the Imperial College. With the higher paraffins, excluding ethane, Townend's experiments showed distinct two-stage ignition behaviour with well-defined regions of cool flame. In this respect the ignition behaviour of methane – air mixtures was shown by these experiments to be different from that of the higher paraffins from propane upwards.

The ignition of methane – air mixtures in rapid compression machines has been investigated by Fenning and Cotton[3], also by Dixon and Harwood[4]. Fenning and Cotton found considerable scatter of the experimental points, indicating a possible region of ignition at temperatures some 40°–50° C. below the final ignition temperatures.

The experiments now reported were carried out in a motored engine in which the compression ratio could be varied continuously between the limits of 4 and 28 to 1 while the engine was running. Separate observation windows were arranged to give a view through the cylindrical combustion space, also down into the cylinder bore. The combustion-chamber pressure was recorded with a cathode-ray oscilloscope. It has been observed that the ignition of methane – air mixtures may be accompanied by either 'blue' flame, or by considerably more intense 'white' flame. The first mode of ignition, to give a blue flame, was found to occur at approximately 16·8 to 1 compression ratio at a mixture strength of 70 per cent of the chemically correct. The measured pressure at the end of compression was 37 atmospheres. At compression ratios greater than 20·2 to 1, the mixture would ignite, giving blue flames and occasional white flames. As the compression ratio was raised, the white ignitions were more frequent. Above a compression ratio of 23·6 to 1, the ignitions were entirely white and the engine would then fire regularly. The entirely blue ignitions were found to correspond with pressure records showing a much-delayed pressure rise as in Fig. 1. The white ignitions give records as shown in Fig. 2.

Experiments performed in a similar manner with higher normal paraffins also exhibited distinct blue and white ignitions, giving characteristic pressure records. This has been confirmed for propane and *n*-heptane. Fig. 3 shows pressure records taken with *n*-heptane. Several cycles are shown giving blue flames with single-stage ignition, followed by one cycle of intense white ignition giving two-stage ignition. This observation is in general agreement with the experiments of Jost[5], of F. A. F. Schmidt[6] and of Taylor, Taylor *et al.*[7] using rapid-compression machines.

Ignition in engines at temperatures far below the final ignition temperature of the fuel – air mixtures with petrol has been reported by Mondain-Monval[8],

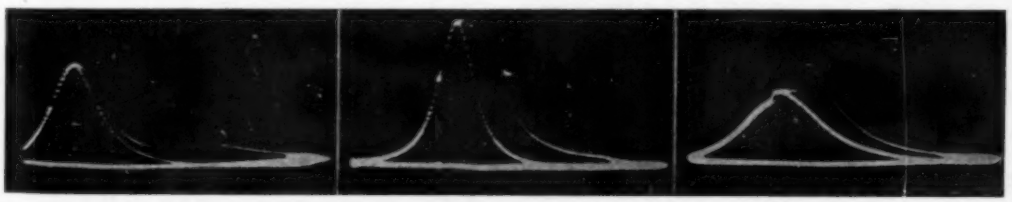

Fig. 1. Blue ignition. Fuel, methane. Mixture ratio, 70 per cent chemically correct. Compression ratio, 16·8 : 1. Time interval between dots, 0·0067 sec. (approx.)

Fig. 2. White ignition. Fuel, methane. Mixture ratio, 70 per cent chemically correct. Compression ratio, 24·0 : 1. Time interval between dots, 0·0067 sec. (approx.)

Fig. 3. Several cycles of blue ignition followed by a single cycle of white ignition. Fuel, heptane. Mixture ratio, 75 per cent chemically correct. Compression ratio, 9·5 : 1

by Peletier *et al.*[9] and by E. Schmidt *et al.*[10]. Very recently, Pastell[11] has reported ignitions in an engine to give regions of auto-ignition, also regions of so-called 'cool-flames'. The boundaries of the separate regions have been defined for *n*-heptane, *iso*-octane and *n*-pentane.

It should be emphasized that the present experiments do not in themselves prove that there is a cool-flame region with methane, but simply indicate that there appears to be at least two distinct modes of ignition under adiabatic compression conditions. Experiments are also being made by Downs *et al.*[12] in the laboratories of Messrs. Ricardo and Co. We wish to acknowledge helpful discussions with them of the experimental methods in the early stages of the work here presented.

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Structure of the Sigma-Phase in the Iron–Chromium and Cobalt–Chromium Systems

The application of X-ray single-crystal and powder methods has shown that the σ-phase structure is based on a tetragonal unit cell, containing 30 atoms, with space group $P\ 4/mnm$, $P\ 4mn$ or $P\ \bar{4}n2$. For the σ-phase of iron–chromium, $a = 8{\cdot}790$ A., $c = 4{\cdot}559$ A. This cell is not the same as found by Duwez and Baen[1] using powder methods only.

While engaged in analysing this structure, we had the opportunity of seeing a paper on the atomic arrangement in β-uranium by Tucker[2], and were extremely interested to note that the β-uranium structure appears to be essentially the same as that of the σ-phase. The discovery of this relationship (the evidence for which is reviewed elsewhere[3]) thus affords a solution of the long-sought-for atomic structure of this intermetallic compound, which is of such high technical importance. The refinement of the structure of σ-phase of cobalt–chromium is now proceeding, and it is intended to investigate the phase where it occurs in other systems—in particular, accurate determination of the intensities of X-ray reflexions for the σ-phase of iron–molybdenum should enable any ordering of the different atoms to be detected.

According to Tucker, the atoms in β-uranium lie approximately in sheets perpendicular to the (tetragonal) *c*-axis, with a marked pseudo-hexagonal symmetry along this axis. A discussion of the relationship between the σ-phase, the body-centred cubic and the α-manganese structures, and accurate determinations of electron distributions for both β-uranium and σ-phase structures, will be of great theoretical interest.

We are indebted to Mr. Charles W. Tucker, jun., for his willing co-operation in making available to us, prior to publication, the full details of his β-uranium structure.

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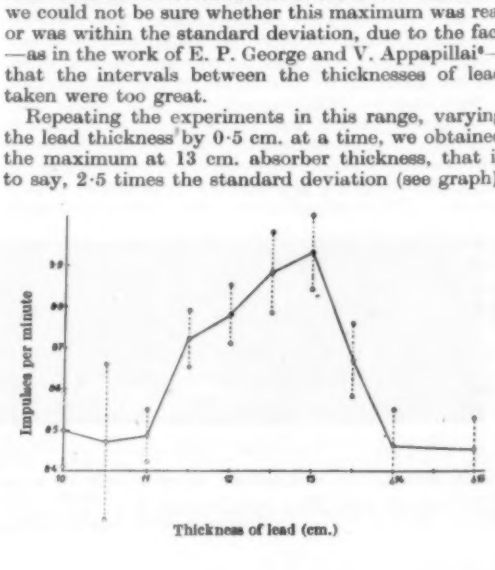
Anomalies in the Absorption Curve of Cosmic Rays in Lead

In connexion with the work of E. Fenyves and O. Haiman[1], the results obtained in this Institute[2] may be of interest. In 1947, we repeated the measurements made by Boethe and Kolhörster[3], Rossi[4], and Auger, Leprince-Ringuet and Ehrenfest[5], in order to obtain the absorption curve of the vertical component of cosmic radiation in lead, at sea-level, in Buenos Aires (lat. 34° 35′ 30″).

For this work, we used triple-coincidence counters with counter-telescopes, their cathodes being coated with silver and anodes with molybdenum, containing a mixture of argon and amyl acetate. The pressure of this mixture was 10 cm. mercury, and we placed above the counter tubes blocks of lead of thickness 2, 5, 7, 10, 12, 15 and 20 cm.

Our curve was not in agreement with those obtained by the above-mentioned authors. It showed a maximum at 12 cm. thickness of absorber. However, we could not be sure whether this maximum was real or was within the standard deviation, due to the fact—as in the work of E. P. George and V. Appapillai[6]—that the intervals between the thicknesses of lead taken were too great.

Repeating the experiments in this range, varying the lead thickness by 0·5 cm. at a time, we obtained the maximum at 13 cm. absorber thickness, that is to say, 2·5 times the standard deviation (see graph).



These measurements were carried out in the laboratory, so we had to apply the corresponding correction (30 cm. of concrete, equivalent to 5–6 cm. of lead) and we obtained a maximum at 18–19 cm. of lead. We did not correct the intensities for temperature and barometric pressure, and our minimum thickness of absorber material was only 20 cm.

We are at present carrying out further theoretical and experimental investigations, in order to be able to explain these anomalies.

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Refractive Index Correction in Relative Raman Intensity Measurements

The development of automatically recording Raman spectrometers has led to increased use of Raman intensities for the quantitative analysis of liquid mixtures. A method frequently adopted is to choose a Raman line characteristic of one component and to compare its intensity in the mixture with that in the pure component. This may be done either directly or (as with the so-called scattering coefficients of Rank and co-workers[1]) by means of an auxiliary reference substance. The basis of the analysis is the assumption that the Raman intensity is directly proportional to the volume concentration. The purpose of this communication is to direct attention to the fact, apparently not previously taken into account, that even if the assumption were completely valid with respect to the total Raman scattering, it would not be valid for the intensities as measured with a spectrometer. The reason is that, on account of the different refractive indices of the two liquids which are compared, there will be different amounts of refraction of the scattered light as it emerges from the Raman tube; and in consequence the effective volumes of scattering liquid 'seen' by the spectrometer will be different.

The light flux passing through the collimator of a spectrometer from a spatially extended source of uniform luminosity has been considered by Nielsen[2]. By extending his treatment, which was restricted to a source of refractive index equal to that of air, we find that for a source of refractive index μ the light flux is less by the factor $1/\mu^2$. The same result is obtained whether or not a condensing lens is used between Raman tube and spectrometer. Hence in order to obtain the true ratio of the Raman intensity of a component in a mixture (refractive index) to its intensity in the pure component (refractive index μ_0), the observed ratio must be multiplied by the correction factor $(\mu / \mu_0)^2$.

With the experimental accuracy at present attainable, the omission of this correction causes no appreciable error in the analysis of mixtures (for example, of similar hydrocarbons) where the components have nearly equal refractive indices. For mixtures of hydrocarbons of different kinds (for example, paraffinic and aromatic) the correction becomes significant; and for other mixtures it can far exceed the limits of error. As experimental accuracy is improved, the correction will become correspondingly more important.

The value of the correction factor given above is for uniform luminosity of the liquid, a condition well realized when Raman tube and lamps are surrounded with reflectors, In applying the method for the quantitative analysis of liquids involving considerable differences of refractive index, the use of such an arrangement would seem to be important; for with non-uniform irradiation it would be practically impossible to calculate the magnitude of the refractive index effect.

The full theoretical treatment will be published elsewhere. It is also intended to carry out experimental tests of the applicability of the correction, using suitably chosen liquids.

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Measurement of Contact Potentials at the Oil–Water Interface

Although the contact potential of the air–water interface is easily measured[1], this is not so for the oil–water interface. Many measurements have been made on the latter system; but in all cases the change in contact potential, ΔV, caused by the spreading or adsorption of a monolayer, decreases with time[2–4], or is but "moderately reproducible"[5]. Indeed, ΔV often reaches zero after only a few minutes. These difficulties have been shown[6] to be due to the diffusion of traces of ions from the aqueous phase into the oil, until at the equilibrium concentrations these 'counter-ions' balance out the potential due to the film.

The only way to overcome this difficulty is by the use of an oil such as petrol-ether (specific resistance about 10^{16} Ω) in which ions are too insoluble to build up a double layer on the oil side of the interface[3]. This means also that little direct current can pass through the oil phase, and recourse to A.C. measurement of the contact potential with a vibrating plate[7] is necessary.

In the present investigation, a gold disk, 2 cm. in diameter, is vibrated while immersed in the oil phase. To avoid disturbing the interface, it is necessary that the amplitude of vibration should be as small as possible (less than 0·01 cm.) and that the disk should not be closer than 0·5 mm. to the water surface. For these reasons the accuracy of measurement of ΔV at the oil–water interface is necessarily less than for the air–water system. Nevertheless, by using a specially designed tuned amplifier, it has now been found possible to measure ΔV for films spread at the petrol-ether–water interface with an accuracy of 1 mV. (about 0·3 per cent).

Using petrol-ether (boiling point above 120° C.), we have obtained *permanent* changes in V when a monolayer is spread. Just as in the familiar case of the air–water surface, the film can be compressed, and a plot of ΔV vs. A is easily obtained. Here A is the area occupied by each long-chain ion in the surface,

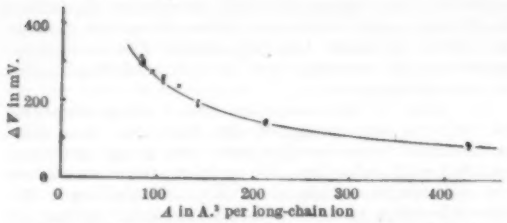

Fig. 1. ΔV against A for monolayers of $C_{18}H_{37}N(CH_3)_3^+$ on 0·1 N NaCl: ●—●—, oil–water; ×—×—, air–water

We have studied the insoluble 'gaseous' films formed at the oil – water interface from the quaternary ions $C_{18}H_{37}N(CH_3)_3^+$ and $C_{16}H_{33}N(CH_3)_3^+$. Fig. 1 shows that the potentials of the C_{18} long-chain ions are the same as at the air – water interface for a given value of A, while Fig. 2 indicates how μ, the apparent surface dipole moment ($= A.\Delta V/4\pi$), changes with the ionic strength of the aqueous phase. Were these gaseous films composed of neutral molecules, the μ vs. A line would be straight and of zero slope.

There are three particular advantages in making measurements on films at the oil – water interface: (1) Stable gaseous films of very long-chain detergents can be studied even when the ionic strength is extremely low. Shorter-chain compounds, which are required if the film at the air – water interface is to be gaseous, are soluble unless the ionic strength is quite high, when exact mathematical treatment of the system is impossible. (2) Proteins and other molecules of biological interest spread very readily, and are in an environment analogous to that at the lipid – water interface *in vivo*. In fact, ΔV is found to be considerably less than at the air – water interface in most cases. (3) Comparison of the 'thermodynamic' potential, ΔV, can be made with the electrokinetic potential, ζ, which has been measured for oil drops in the presence of various amounts of detergent. In this way information about the position of the plane of shear may be obtained.

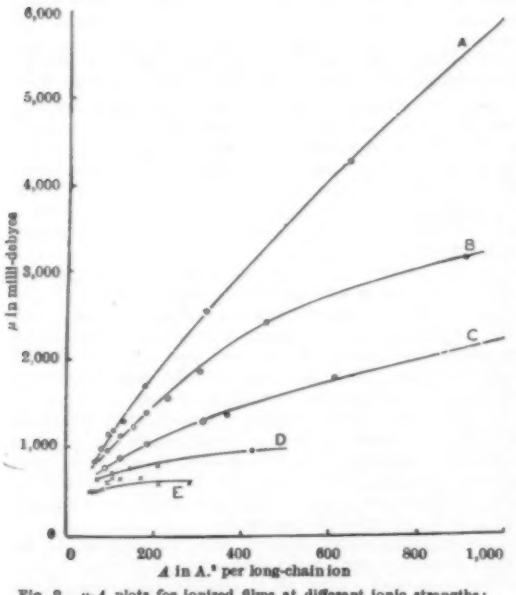

Fig. 2. μ-A plots for ionized films at different ionic strengths; (*A*) 10^{-5} N NaCl, $C_{18}H_{33}N(CH_3)_3^+$ (oil–water); (*B*) 10^{-3} N NaCl, $C_{18}H_{33}N(CH_3)_3^+$ (oil–water); (*C*) 10^{-2} N NaCl, $C_{18}H_{33}N(CH_3)_3^+$ (oil–water); (*D*) 10^{-1} N NaCl, $C_{18}H_{37}N(CH_3)_3^+$ (air–water); (*E*) 2 N NaCl, $C_{18}H_{37}N(CH_3)_3^+$ (air–water)

A full account of these results, including a new surface equation of state for ionized films, and of the mechanical and electrical details, will be published elsewhere. I am indebted to Prof. E. K. Rideal for his interest in this work.

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Quality-Control Chart based on Goodness-of-Fit Test

DURING the course of detergency investigations involving the measurement of the reflectance of fabrics, the need arose for a rapid method of deciding whether the reflectance – frequency distribution of successive samples conformed to an expected distribution previously built up from a large number of such measurements. A suitable method based on the χ^2 goodness-of-fit test was devised; and it is thought that this may be useful to others concerned with frequency distributions, especially of non-normal types. The method is a form of quality control.

A chart is prepared with a number of vertical blocks (as in a histogram) divided into cells by equally spaced horizontal lines. In the extreme right and left margins the cells are numbered upwards from zero. Below each block is written the appropriate class-value (x). To apply a valid χ^2 test, no class expectation should be less than 5; this condition may be met by pooling terminal cells and by selection of the grouping unit. The expected frequencies in each class (rounded to the nearest whole number) for a fixed, convenient sample size are known either from a theoretical distribution or from experience with very large samples. The cells corresponding to the expected frequencies are numbered 0, and the successive cells above and below, ± 1 ± 2 ± 3 . . . ; these numbers show the deviations (d) from expectation. The shape of the expected distribution can be shown clearly by blocking in the zeros.

Values of χ^2 contributions (c) for deviations of 1, 2, 3 . . . are worked out for each class (since the expectations are fixed) and listed below. Rough 'control limits' for each class are set up as follows. For the appropriate degrees of freedom (depending on the distribution considered) the value of χ^2 at any desired probability (P) level is divided by the number of classes (n), thus allotting an equal fraction of χ^2 to each class. Then if each class contributes this quantity, the total χ^2 will just reach significance at the chosen level of P. The maximum deviation d_m which will give such an aliquot of χ^2 for any class having an expectation E is:

$$d_m = \sqrt{\frac{\chi^2 E}{n}}.$$

The values of d_m so obtained should be rounded *downwards* to a whole number, and distinctive control lines drawn enclosing the appropriate number of cells on either side of zero (E).

For use, markers are placed in the bottom cell of every class. If the chart is used horizontally disks are suitable markers, while, for vertical fixing, flags, or pegs in holes, may be used. After each measurement the marker in the appropriate class is advanced one cell. When the whole sample has been measured the markers will show the approximate shape of the distribution. If all the markers lie inside the control lines, then the total χ^2 cannot reach significance at the chosen level of P, though it may appear to be suspiciously large. The actual value of χ^2 can be obtained rapidly from the prepared lists by summing the n contributions corresponding to the indicated deviations. (A set of values of χ^2 for common levels of P may usefully be appended to the chart.) The actual sample frequency distribution can be quickly written down from the marginal scales of absolute frequencies (f).

A significant value of χ^2 will show that the sample does not conform to the expected distribution but will not of itself indicate the nature of the divergence. A rough idea may, of course, be obtained by noting which classes make the largest contributions; but where, as in quality-control work, action may have to be taken if the divergence is significant, a more definite criterion is desirable, particularly if such methods are operated by semi-skilled personnel. One solution is to use the mean. This can be calculated rapidly by providing each class with a prepared list of fx products; if these are suitably adjusted in relation to sample size, simple addition of n products will give the mean directly. An alternative procedure which we have found useful is to give each class a weighting coefficient (w) with positive or negative sign. If the deviation in each class (with appropriate sign) is multiplied by its weighting coefficient and the products added, the sign of the final sum will at once indicate the direction of the divergence from the expected distribution. The choice of values and signs for w will depend on technological factors.

f						f
20						20
19						19
18				+5		18
17				+4		17
16			+5	+3	+5	16
15			+4	+2	+4	15
14			+3	+1	+3	14
13	+5 ▲		+2	●	+2	13
12	+4	+5 ▲	+1	−1	+1	12
11	+3	+4	●	−2	●	11
10	+2	+3	−1	−3 ▲	−1	10
9	+1	+2	−2 ▲	−4	−2	9
8	●	+1	−3	−5	−3	8
7	−1	●	−4		−4	7
6	−2	−1	−5		−5 ▲	6
5	−3	−2				5
4	−4	−3				4
3	−5	−4				3
2		−5				2
1						1
0						0
x	94 or less	96	98	100	102 or more	x
w	−2	−1	0	+1	+2	w
d	c	c	s	c	c	d
1	0·12	0·14	0·09	0·08	0·09	1
2	0·50	0·57	0·36	0·31	0·36	2
3	1·12	1·29	0·82	0·69	0·82	3
4	2·00	2·29	1·46	1·23	1·46	4
5	3·12	3·57	2·27	1·93	2·27	5

● Expected frequencies.

▲ Observed sample frequencies (markers).

The numerical value of such an empirical index is highly correlated with both the arithmetic mean and the magnitude of χ^2. By trials with a number of independent samples, it is possible to find the relationship. Our trials have shown that there may be anomalies in that sometimes moderately large values of the index are associated with non-significant values of χ^2, whereas on other occasions significant values of χ^2 are associated with rather small index values. However, where technological decisions are involved it is always possible, by a suitable choice of significance-levels and instructions, to reduce the chance of errors of the first and second kind to known levels.

The accompanying typical chart is for a sample of 50. Control lines are based on 5 per cent significance of χ^2 for 4 degrees of freedom. For the particular sample shown, the indicated value of χ^2 is 10·01, and of the empirical index − 28. Since the 5 per cent point for χ^2 in this example is 9·49, the sample differs significantly from expectation; the high negative value of the index shows that the divergence arises from an excess of individuals having low x values.

Because of the additive property of χ^2, accumulated sample data may be used to check the correctness or stability of the expected distribution.

We wish to thank K. L. Daniell for helpful discussion, and the Director of Research of this Association for permission to publish this note.

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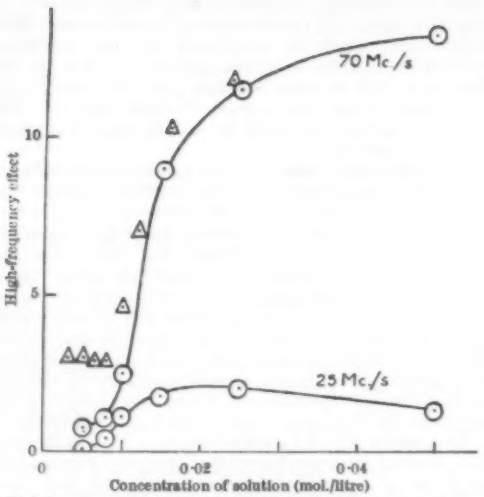
High-frequency Conductivity of Paraffin-chain Salts

Some years ago, Schmid and Larsen[1] published the results of an experimental study of the electrical conductivity at high frequencies (15 and 25 Mc./s.) of aqueous solutions of sodium dodecyl sulphate and cetylpyridinium chloride. Recently we have re-investigated these salts, at the same temperature (25° C.), over wider ranges of frequency and concentration. From the accompanying diagram it is evident that discrepancies exist between the new results and those obtained in the earlier work.

The 'high-frequency effect' in the diagram is the fraction

$$100\,\frac{(\Lambda_\infty - \Lambda_0)}{\Lambda_0},$$

where Λ_0 is the low-frequency equivalent conductivity (determined at 1,000 c./s.), and Λ_∞ is the 'apparent' high-frequency equivalent conductivity, which is the low-frequency equivalent conductivity of the solution of potassium chloride having the same resistance at high frequency as the solution of the paraffin-chain salt[2]. To obtain the true value of Λ_∞, allowance



High-frequency effect for sodium dodecyl sulphate. (—▲—, Schmid and Larsen's data at 25 Mc./s.)

must be made for the change with frequency of the resistance of the potassium chloride solution; for the sake of direct comparison with Schmid and Larsen's figures, this small correction (+ 0·4, or less, unit of high-frequency effect) is omitted. Our determinations of the high-frequency effect were found to be reproducible to within about ± 0·2 unit.

At concentrations greater than the 'critical' (0·008 molar), Schmid and Larsen's points deviate widely from our curve for 25 Mc./s., but lie near our curve for 70 Mc./s. For concentrations less than the critical, Schmid and Larsen show a constant effect of 3 per cent, whereas our measurements give much smaller increases, even at 70 Mc./s.

It seems probable that the discrepancies at the higher concentrations are connected with a difference in experimental method. The present results were obtained by a resonance method, so that the circuit containing the conductivity cell was separate from, and only loosely coupled to, the high-frequency valve oscillator. Schmid and Larsen, however, employed a modification of Deubner's method in which the cell was connected, *via* isolating capacitors, across the tuned circuit of the oscillator[3]. We suggest that, at the higher concentrations of sulphate, the cell resistance was sufficiently low for the frequency to be no longer determined by the tuned circuit but by other unintentional components of smaller inductance and capacitance. Hence Schmid and Larsen's measurements would unwittingly be made with oscillations of a higher frequency than they anticipated, and the similarity between their results and ours at 70 Mc./s. would be satisfactorily explained. This view is further supported by the measurements for the much more dilute solutions (0·001–0·003 molar) of cetylpyridinium chloride, where rough agreement between the two sets of results was found. Presumably, in this case, the cell resistance in Schmid and Larsen's experiments was high enough to ensure that the operative frequencies were at least near the stated values.

The concentration-independent 3 per cent effect reported by Schmid and Larsen for concentrations of the dodecyl salt below the critical, and attributed by these workers to 'dipole absorption', is difficult to understand. We were quite unable to confirm its existence.

A full account of the present work will be published elsewhere. The results, which can be qualitatively interpreted in terms of the Debye–Falkenhagen theory[2] of the dependence of conductivity on frequency, indicate that the 'relaxation-effect' has abnormally large values in micellar solutions of paraffin-chain salts.

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Effect of Low Polymer upon the Intrinsic Viscosity of a High Polymer

When it is desired to express the results of solution viscosity measurements upon a high polymer as a molecular weight, the viscosity average molecular weight M is used. The concept is due to Flory[1]. Its starting assumption is that, for the ith component of a polydisperse polymer sample,

$$(\eta_r - 1)_i = KC_i M_i^{a}, \qquad (1)$$

where $(\eta_r - 1)$ is the relative viscosity increment due to the ith component, and C_i and M_i are its concentration and molecular weight. K and a are constants, assumed to be specific to the polymer/solvent system generally, and not to the particular component considered in equation (1). This contention would not be expected to be rigorously true, because the viscosity increment due to the ith component, which depends on its effective radius in dilute solution, would be affected not only by C_i and M_i, but also by the concentrations and molecular weights of all other species present. These other species, together with the solvent, will enter into the general interaction between polymer segments and solvent molecules upon which the final effective radius of the ith component will depend.

It was decided to examine the question experimentally in the following way. The viscosities were measured at 25° C. of solutions of different concentrations of a high-molecular weight polystyrene X in the following solvents: (1) benzene; (2) a 0·6 per cent solution in benzene of a low-molecular weight polystyrene A; (3) a 1·0 per cent solution of A in benzene. Ideally, of course, the polymer X should be homogeneous by analogy with the ith component of equation (1); but this is impracticable and the employment of the heterogeneous polymer X does not invalidate the general conclusion, as will be seen.

The quantity $\eta_r - 1/C$ was plotted against C and the zero concentration intercept, $[\eta]$, read off in the ordinary way. It will be recalled that this procedure automatically allows for the viscosity increment of the solvent itself. If the low polymer A did not affect the extent of coiling of X, as it would not do if equation (1) were valid, the same intercept should be obtained in each of the three cases mentioned above. The results which were actually obtained disprove this. The relationship between $(\eta_r - 1)/C$ and C was found to be linear in all three cases and expressible by the following equations:

Polystyrene X in benzene: $(\eta_r - 1)/C = 1{\cdot}662 + 0{\cdot}542\,(C - 0{\cdot}585)$
Polystyrene X in a solution of 0·6096 gm. polystyrene A per 100 c.c. $(\eta_r - 1)/C = 1{\cdot}494 + 0{\cdot}434\,(C - 0{\cdot}520)$
Polystyrene X in a solution of 1·0145 gm. polystyrene A per 100 c.c. $(\eta_r - 1)/C = 1{\cdot}426 + 0{\cdot}393\,(C - 0{\cdot}518)$

The effect of the addition of low-molecular weight polymer on the relationship between $(\eta_r - 1)/C$ and C is given in the accompanying table:

Solvent concentration of A in benzene	Regression coefficient and standard error	Intercept and standard error
Nil	0·542 ± 0·0054	1·335 ± 0·0035
0·6 per cent	0·434 ± 0·016	1·268 ± 0·010
1·0 „	0·393 ± 0·022	1·223 ± 0·013

The last column of the table gives the zero concentration intercept, $[\eta]$, in respect of X. This is seen to be dependent upon the concentration of A; evidently the higher the concentration of A, the more tightly X is coiled.

I thank Miss Y. M. Pike, who made the viscosity measurements, and Mr. A. G. Goodchild, who carried out the mathematical analysis of the data. I also thank the Distillers Company, Ltd., for permission to publish this note.

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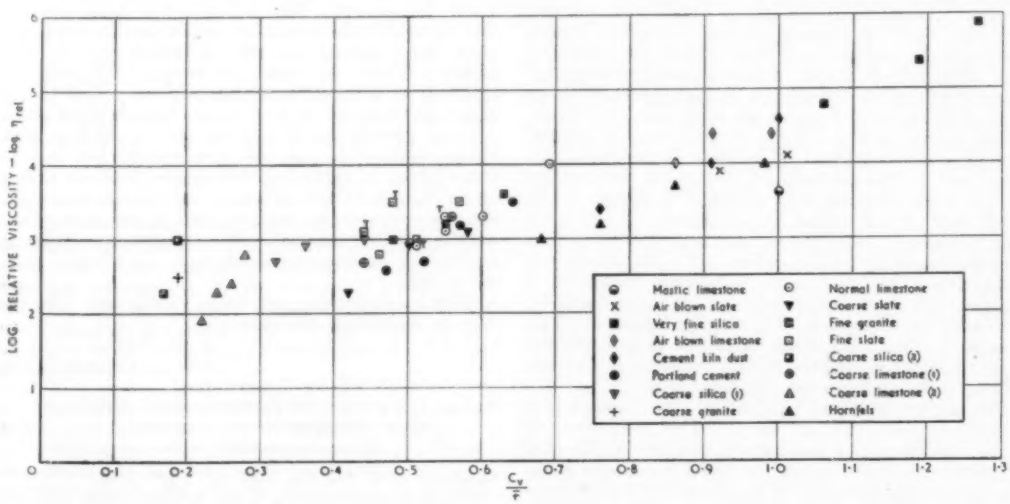
Rheology of Suspensions of High Solid Concentration

One of the most general problems in technical rheology is that of relating the flow properties of solid-in-liquid suspensions to the physical properties of the separate liquid and solid phases. The Bituminous Materials Section of the Road Research Laboratory has been interested for some time in the behaviour of systems consisting of fine mineral powders dispersed to very high concentrations in tars and bitumens which are substantially Newtonian liquids of high viscosity. The problem to be solved can be stated in the form of the following question: What physical characteristics of dry powders determine the relative viscosity of powder-in-liquid dispersions over the widest possible range of concentration? The Einstein equation and various modifications and elaborations of it for higher concentrations have not provided the answer to this question.

The investigations have indicated the importance of the fractional volume of voids in the compacted, dry powders as a factor controlling the relative viscosity of powder-liquid systems. Some earlier work[1] had shown that the use of this voids fraction enabled relative viscosity/concentration curves for low concentrations for widely differing powders to be related. More recently, attention has been given to systems of very high solid concentration, that is, near the point where the void space in the dry, compacted powder is just filled with liquid. Such dispersions are 'solid' materials of very high viscosity at ordinary temperatures, and their viscosities have been measured by a simple, constant-load, cylinder-compression test.

The void structure of the dry powders, in the same degree of packing as in the dispersions, has been examined and a method developed for determining the mean pore radius $(\bar{r})$ of the pores constituting these voids. The method has been developed from earlier work[2] on the theory of the air-permeability method for measuring specific surface of fine powders. It consists essentially of measuring the rate of flow of air through the compacted powder under a known pressure gradient over a range of mean air pressures (that is, over a range of mean free path, λ). A plot of air-permeability against λ is found to be accurately linear from atmospheric pressure down to 1 or 2 cm. mercury, and from the slope and intercept of this plot the value of mean pore radius $(\bar{r})$ of the powder can be simply calculated from the usual combined Poiseuille–Knudsen equation for gas flow through a capillary.

Now, in a powder-in-liquid dispersion of solid concentration C_v, the fractional voids, ε, in the powder is occupied completely by the liquid phase $(\varepsilon = 1 - C_v)$, and the pores comprising the voids consist, therefore, of filaments of the liquid. It is reasonable to suppose that the mean size of these pores



(as well as their total volume) is related to the relative viscosity of the dispersion. The mean pore radius ($\bar{r}$) should be, in fact, an inverse measure of the particle-particle interference. Experimental results obtained on a very wide range of powders differing in mineral type and fineness have shown that this idea is promising. The accompanying graph shows the correlation obtained between log $\eta_{R.L.}$ (at 15° C. and at a single shear stress) and $C_v/\bar{r}$, where the liquid phase consisted of a bitumen of substantially Newtonian flow characteristics with viscosity at 15° C. of $2{\cdot}72 \times 10^6$ poises. Forty-five different systems are plotted in the graph, and include sixteen different powders (seven different mineral types). The values of $\bar{r}$ range from $0{\cdot}4\,\mu$ to $4\,\mu$.

So far, the method has only been applied to systems having solid concentrations high enough to enable the same degree of powder packing to be achieved in the dry state for the purpose of measuring $\bar{r}$. The possibilities of extrapolating to lower concentrations are still being examined. A detailed account of this work is being prepared for publication elsewhere.

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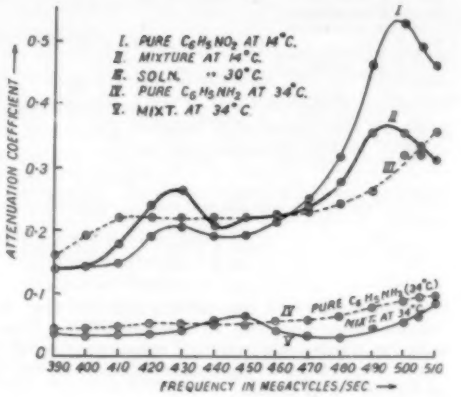
Nature of Grouping of Molecules in Opalescent Binary Liquid Mixtures

It is well known that certain binary mixtures of organic liquids show opalescence at suitable temperatures. It was first shown by Krishnan[1] that the value of the factor of depolarization of the light scattered transversely by such a mixture with the incident light vector horizontal is different from unity, and this was ascribed by him to the formation of large clusters of molecules in the mixture. Although the opalescence is certainly produced by local fluctuations in density, the light-scattering data cannot furnish definite information regarding the actual composition of the particles producing the opalescence. It has, however, been shown recently by Sirkar and Sen[2] and also by Sen[3] that many ordinary organic liquids having polar molecules exhibit strong absorption in the ultra high-frequency region at suitable temperatures, and that the frequency in the region of absorption gives us an idea about the magnitude of viscous forces acting on the individual molecules, as pointed out by earlier workers. Since such viscous forces are produced by the surrounding molecules, any change in the intermolecular field produces a change in the frequency of the region of absorption of the ultra high-frequency radio waves, and this method is thus suitable for studying the nature of the intermolecular field acting on the individual polar molecule in opalescent binary liquid mixture. A programme for studying the absorption of ultra high-frequency radio waves in such opalescent mixtures has, therefore, been undertaken and the results obtained in the case of two such mixtures are discussed here.

A mixture of equal weights of nitrobenzene and hexane is opalescent at 14° C. The absorption of ultra high-frequency radio waves observed in the case of such a mixture, using the same technique as in previous investigations[2], is shown in the accompanying graph along with that for the mixture at 30° C.



and the pure liquid at 14° C. The graph also includes similar data for an opalescent mixture containing 46 per cent by weight of aniline and 54 per cent of cyclohexane at 34° C. and for pure aniline at 34° C. (curves IV and V). It can be seen from curves I and II that in the case of the opalescent mixture of nitrobenzene there is a new absorption peak at about 427 Mc./sec., besides a peak in the original position at 496 Mc./sec. The height of the latter peak, however, is much less than that observed in the case of the pure liquid. In calculating the attenuation coefficient in the mixture, the equivalent thickness corresponding to the percentage of the liquid in the mixture has been taken, and therefore the height of this peak indicates the percentage of the molecules still existing in the same environment as in the pure liquid. The new peak disappears when the temperature of the mixture is raised to 30° C., at which the opalescence vanishes; but the peak at 496 Mc./sec., instead of disappearing completely, shifts towards higher frequencies. Even in the case of pure nitrobenzene, there is indication of a low broad peak at 427 Mc./sec., and its height increases in the opalescent mixture.

This new peak is not due to associated molecules, because the size of the associated molecule would be large enough to shift the peak to regions of much lower frequency. We believe the new peak is due to molecules subjected to viscous forces larger than those acting on the molecules in the pure liquid. Thus in the opalescent mixture, in addition to a small percentage of molecules in the same environment as in the pure liquid, there exists a small percentage of nitrobenzene molecules more closely packed than in the pure liquid; but in both these types of groupings the single molecule is free to oscillate with the impressed electromagnetic field. Since similar results are obtained in the case of the aniline – *cyclo*hexane mixture, the phenomenon seems to be characteristic of all strongly anisotropic polar molecules.

The investigations are being continued. Details will be published elsewhere.

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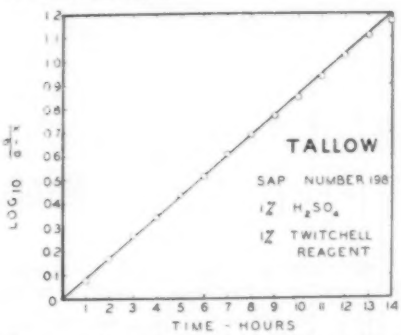
Kinetics of the Twitchell Hydrolysis

THE hydrolysis of fats in a dilute sulphuric acid medium using a catalyst commonly known as Twitchell reagent has been believed for nearly half a century[1] to take place at the interface of oil and water, the reagent fulfilling the function of an efficient emulsifier. Recently, however, Lascaray[2] suggested that the reaction is essentially homogeneous and is carried out in the oil phase under the influence of water dissolved in this phase. Convincing as his arguments are, he did not consider the kinetic order of the reaction, the study of which proved valuable in elucidating the related fat hydrolysis by acidification[3]. This omission was probably due to the existence of an induction period in the Twitchell process which tends to obscure its kinetics.

Kinetic measurements of the Twitchell hydrolysis carried out in this Laboratory on a number of fats and with various reagents showed that the reaction is of the first order throughout, if started in the presence of 1 per cent by weight (calculated on the fat) of sulphuric acid in the form of 10 per cent aqueous solution. In order to approach industrial practice, this was followed by a continuous addition of water (up to 100 per cent by weight of the fat) as the hydrolysis proceeded, the mixture being kept at 100° C. A run conducted under these conditions is shown in the accompanying graph in which $\log \frac{a}{a-x}$ (a is saponification number, x is acid value) plotted against time gives a straight line, an indication of a first-order reaction. This kinetic order can be accounted for in the simplest way by assuming that the reaction takes place in the oil phase, which seems to confirm Lascaray's views. A heterogeneous reaction would be less likely to give a consistent kinetic order in view of the gradual addition of water and the accompanying changes in the interfacial surface, while hydrolysis in the water phase would probably result in zero-order kinetics.



At the same time, it appears that the initial concentration of sulphuric acid given above, which is higher than that usually employed, assists the hydrolysis by eliminating the induction period and therefore has a potential application in practice. Other consequences arising therefrom, such as the possibility of a continuous Twitchell process, will be discussed elsewhere.

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Influence of Œstrogenic Hormones on the Reticulo-Endothelial System in the Guinea Pig

FEW observations have been recorded on the action of œstrogens on the reticulo-endothelial system, and there is considerable disagreement concerning their action upon the histiocytes. Fluhmann, working with the rabbit[1], and Nicol with the guinea pig[2], showed that injection of œstrogenic hormones stimulated the appearance and activity of phagocytic cells in the endometrium of the uterus, as evidenced by the capacity of the cells to take up trypan blue. This was associated with growth and enlargement of the uterus. They considered these cells to belong to the reticulo-endothelial system. Nicol believed they were derived partly via the blood stream and partly from the connective tissue of the endometrium, and that the activity of these cells in some manner prepared the endometrium for the subsequent action of the luteal hormone. Fluhmann regarded these cells as scavengers.

Leites and Riabow[3] stated that splenectomy combined with ovariectomy creates the optimum condition for the experimental blockade of the reticulo-endothelial system, while Haendel and Malet[4] pointed out that ovarian extracts stimulated the reticulo-endothelial cells. Mosinger[5] states that, in the guinea pig, prolonged administration of œstrogens for two to three months produces reticulo-endotheliosis, followed by sclerosis; but his results are not supported by photomicrographs.

At the present time, œstrogens are used in the treatment of prostatic carcinoma, in cancer of the breast, urinary bladder and other organs, with striking results, especially in the prostate. In the case of the prostate, the evidence at present points to the fact that the œstrogens act mainly through the anterior lobe of the pituitary, since similar results can be obtained by deep X-ray of the pituitary and by castration. The beneficial action is accompanied by fibrosis[6-8]; but no definite explanation has yet been found which explains the manner in which the response of the affected tissues is brought about[9]. The present research was designed to study this problem.

For the present investigations the effect of varying doses (0·1–5 mgm. daily for six days) of natural and synthetic œstrogens (œstradiol benzoate, œstrone, stilbœstrol and stilbœstrol dipropionate, D.B.E. (di-*P*-ethoxyphenyl-*B*-phenylbromo-ethylene), and dienœstrol, given intramuscularly or by mouth) on the reticulo-endothelial system in the spleen, liver, uterine horn, lymph nodes, skin and subcutaneous tissue, bone marrow and adrenal glands, was studied histologically on 79 double-ovariectomized sexually mature virgin guinea pigs injected with a 1 per cent solution of trypan blue in distilled water at the rate of 0·8 c.c. per 100 gm. body-weight. Of these animals, six were used as controls and received only injections of trypan blue subcutaneously. The remainder of the animals were divided into six groups, each of which received for six days a different daily dose of œstrogen and also a daily dose of trypan blue.

The effect was measured by the number of dye-bearing cells and the intensity of the vital-staining in the various organs and tissues examined. To ensure reliable comparison, the animals used were killed on what would have been the fifteenth day of the œstrous cycle had the ovaries been present.

It was found that the œstrogenic hormones produce hyperplasia and stimulation of the macrophages in

the spleen, liver, uterine horn and lymph nodes. In the other tissues examined the effect is less marked. In addition, the mesothelial cells of the peritoneum, especially those covering the spleen, become activated, proliferate abundantly and phagocytose the dye granules.

With a daily dose of 0·1 mgm., the descending order of activity of the various hormones in stimulating the macrophages is stilbœstrol dipropionate intramuscularly, œstradiol benzoate intramuscularly, œstrone intramuscularly and dienœstrol by mouth. With a large daily dose of 5·0 mgm. of stilbœstrol dipropionate intramuscularly or dienœstrol followed by stilbœstrol dipropionate by mouth, the macrophages in the spleen, liver and lymph nodes become reduced, while those of the uterine horns are increased in number. This suggests the liberation of mononuclear cells from the former sites, and that their destination was the uterine horns, where they infiltrated the endometrium and were rapidly differentiated into dye-bearing macrophages. Moderate stimulation of the reticulo-endothelial cells was obtained in the spleen, liver, lymph nodes and uterine horns with daily doses of 0·5–1·0 mgm. œstradiol benzoate, 1·0–2·0 mgm. D.B.E. (di-*P*-ethoxyphenyl-*B*-phenylbromo-ethylene), 3·0 mgm. dienœstrol, 5·0 mgm. stilbœstrol dipropionate, and 5·0 mgm. dienœstrol for three days followed by 5·0 mgm. stilbœstrol dipropionate for three days.

In the uterine horns the most intense result was produced by 5·0 mgm. dienœstrol daily for three days, followed by 5·0 mgm. stilbœstrol dipropionate for three days. On the other hand, a daily dose of 0·1 mgm. dienœstrol produced only a very weak effect.

From the known genetic relations between the macrophages and fibroblasts[10,11], it seems likely that this hyperplasia of the macrophages is a stage in the fibromatosis recorded in the guinea pig under continuous and prolonged action of these hormones[12,13]. The fibromatosis is most probably due to the differentiation of the macrophages into fibroblasts.

The present investigations provide evidence that the tissue macrophages are stimulated by the œstrogenic hormones, and that the probable mode of action of œstrogens in the treatment of malignant disease is to build up the resistance of the tissues, and the reproductive system in particular, by providing them with numerous macrophages which, under prolonged œstrogenic action, can differentiate into fibroblasts and produce the sclerosis which accompanies the beneficial action of œstrogenic treatment.

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Oct. 10.

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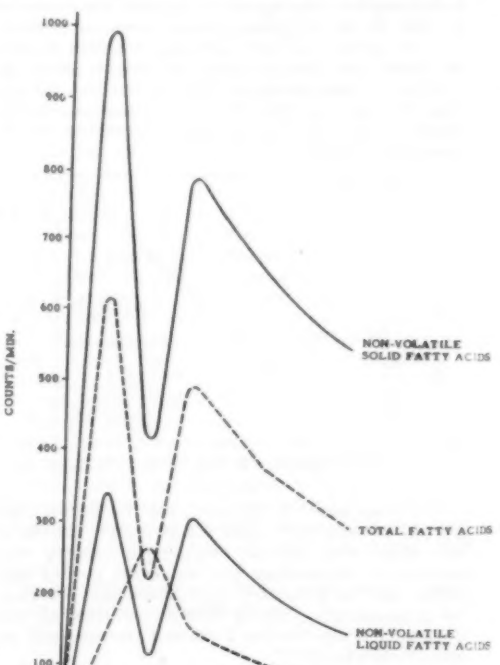
Rapidly Metabolizing Lipid Fraction of the Liver

It was found recently[1] that a rapidly metabolizing fatty acid fraction having a half-lifetime of minutes only is present in the liver of the mouse. The corresponding lifetime of the average fatty acid molecules of the liver is known to be about one day[2,3].

In the present work the rate of incorporation of carbon-14 into the non-volatile solid, the non-volatile liquid fatty acid, and the cholesterol fractions of the liver, isolated at various short intervals after administration of sodium acetate ($NaCH_3{}^{14}COO$), was determined. To five groups of mice, each consisting of twelve animals, 3 microcuries of labelled acetate was injected intraperitoneally; the animals were killed between 15 and 100 min. later. In order to remove urea and other non-fatty impurities possibly present, the petrol-ether - soluble lipid fractions of twelve livers were combined and purified according to Folch and van Slyke[4]. This method involves, however, the loss of some of the phosphatides present. The fatty acids were then prepared by saponification. After being washed first with 5 per cent acetic acid and afterwards with water, the fatty acids were converted into lead compounds according to the method of Twitchell[5]; finally, radioactivity measurements were performed.

As seen in the accompanying graph, the radioactivity of both fatty-acid fractions increases at first, the resorption and distribution of acetate followed by an incorporation of acetate carbon-14 into fatty



Specific activity of fatty acids and cholesterol extracted from the liver of mice after the injection of radio active sodium acetate

acids taking some time. After the lapse of 15 min., or possibly after even a shorter time, a marked decrease in the radioactivity of the fatty-acid fractions takes place. A second maximum of the curves, indicating the change in the carbon-14 content of fatty acids with time, is detectable after 45 min.; the curve showing the cholesterol values, on the other hand, has one maximum only, and this is reached after 30 min.

The ratio between the specific activity of the liquid and the solid fatty-acid fractions amounts to 2·6–3·7. In experiments of long duration (lasting many hours) the ratio between the carbon-14 content of saturated and unsaturated fatty acids was found[3] to be about 2.

As from experiments of long duration the mean half-lifetime of the fatty acid mixture of the liver is known to be 1–2 days, the rapidly metabolizing fraction observed in our work has to be ascribed to the rapid turnover of a minor part of the fatty acids present. This will, however, scarcely influence the results of experiments of long duration.

If the renewal of the carboxyl group of the fatty acids occurs at a much more rapid rate than does the formation of the fatty acid molecules, very pronounced differences in the results of experiments of short and of long duration may be observed. The results obtained by Swan[4], from experiments carried out in this laboratory in which the radioactivity of the carboxyl carbon and the non-carboxyl carbon of fatty acids was compared, make the assumption improbable that such a rapid carboxyl carbon turnover takes place in the fatty acid molecules.

We wish to express our gratitude to Prof. G. Hevesy for his interest in this work.

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Oct. 31.

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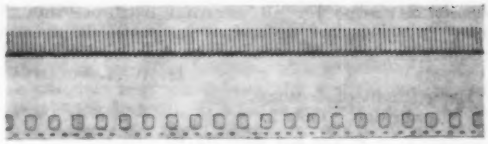
Continuous Electrical Signals from the Tail of a Fish, *Gymnarchus niloticus* Cuv.

Through the kindness of Dr. K. R. S. Morris, Gold Coast, I received a living specimen of *Gymnarchus niloticus*, a fish which occurs in the rivers of West Africa and in the Nile. Observation of this fish in an aquarium has revealed two striking features: (i) a mode of locomotion through waves passing over the extended dorsal fin and executed forwards and backwards with equal ease; (ii) a marked ability of the fish to avoid obstacles while swimming backwards. The hind end and particularly the finger-like tail are known to contain tissues corresponding to an electric organ; it seemed of interest to consider whether this organ may enable the animal to detect objects in the vicinity of its body.

When a pair of electrodes, connected to an amplifier, was placed in the tank with the fish, an uninterrupted stream of electrical pulses could be picked up. Under constant conditions of temperature these signals are emitted with surprising regularity, both in intensity and frequency (see record reproduced herewith). Within the range of 21°–31·5° C., the frequency varies between 258 and 318 pulses per second, with a maximum at 28° C. These pulses do not appear to be dependent on the state of activity of the animal; they remain unchanged whether the fish is swimming or completely at rest. When the electrodes are close to the fish, maximal intensity is obtained by aligning them parallel to the long axis of the animal and placing them near the tail. If the electrodes are then rotated, the size of the recorded impulses will be seen to decrease until, after a turn of 90° (when the connecting line passes through the base of the tail), they are no longer registered. Deflexion from this position either cranially or caudally reverses the polarity to positive or negative respectively. With the electrodes 8 cm. apart and 1 cm. long, maximal values for a fish measuring 28 cm. amounted to about 30 mV.; at a distance of 100 cm. in Cambridge tap water, signals of approximately 30 μV. were observed.



Oscillograph record of continuous signals emitted by *Gymnarchus niloticus*. The temperature of the water was 21° C. Time marker in 0·01 and 0·1 sec.

Details of this investigation will be given elsewhere; but it may be pointed out that *Gymnarchus* obviously appreciates any changes in the electric field which it sets up. The easiest way to demonstrate this is by dipping successively the two ends of a ∩-shaped copper wire into the water near the fish. Characteristic escape reactions are then observed, which do not appear if the wire is replaced by non-conducting material. It has also been shown that if, by means of a beat frequency oscillator, electrical pulses comparable in intensity and frequency to those emitted by the fish are applied to the water, very marked responses are elicited. Similarly, if the fish's own pulses are fed back into the water some distance away from the animal, the fish is able to locate the source of stimulation and attacks the stimulating electrodes. Regnart's[1] finding that the lateral line of other fish is responsible for the lower limits of perception of electric current is of interest in this connexion.

From the evolutionary point of view, these observations may help to resolve Darwin's difficulty in explaining the development of electric organs through natural selection, although the gap between weak electric organs and motor endplates has yet to be bridged. *Gymnarchus* may be by no means unique in possessing such an electric signalling mechanism; suspicion rests particularly on the Mormyridæ and Gymnotidæ*. Unfortunately, while the investigation was still in progress my *Gymnarchus* died, and it appears very difficult to replace this animal or to obtain any Mormyridæ or Gymnotidæ. I should be grateful if anyone who could suggest a possible source of supply would write to me.

**Note added in proof.* Since the above was written, this has been confirmed in *Mormyrops boulengeri* and

Gymnotus carapo for all essential features, though there is a marked difference in pulse shape and frequencies.

H. W. Lissmann

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Factors in the Attractiveness of Bodies for Mosquitoes

The greater part of Canada, particularly the northern forest and subarctic regions, is infested during the summer months by many species of *Aëdes* mosquitoes. Following two years of laboratory investigation of the factors which attract mosquitoes to an animal body, an opportunity was given by the Defence Research Board and the Division of Entomology, Department of Agriculture, to study the responses of the female mosquitoes in the field, both in Ontario and in the interior of Labrador. For this purpose two stainless-steel tanks, each containing 100 lb. of water, were set up 6 ft. apart in a forest glade. They were electrically heated to a constant temperature of 98° F., clothed in a felt shirt and black crepe jerkin, and so shaped and mounted that they resembled dummy men; on occasion a head was added with an orifice for the exhalation of gases.

As a measure of the comparative attractancy of the two robots, the number of landings made by mosquitoes in a given period of time (either 1 or 2 minutes) was counted in a system of replicates. Since position error was insignificant, both normally being equally attractive, any change in the condition of one robot was reflected by the differing attractiveness with respect to the other. The species involved were *A. intrudens* and *A. trichurus* in Ontario, and *A. punctor*, *A. pionips* and *A. communis* in Labrador; no significant interspecific differences could be detected in the results.

It was found that, at air temperatures above 60° F., a robot with moistened clothing attracted two to four times as many mosquitoes as one with dry clothing. At cooler temperatures, and particularly at high humidities, the results were the reverse; the dry clothing attracted up to twice as many mosquitoes as the moist, despite the fact that the temperature of the surface of the dry clothing proved to be 1–3° F. lower than that of the moist.

At air temperatures from 57° to 74° F., the tank of water that was kept at body temperature was found to attract more than three times as many mosquitoes as a tank containing cool water (48°–64° F.). Here the only clothing was a crepe jerkin, and the surface temperature of the clothing of the warm robot was 14°–17° F. higher than that of the cool one. When the tanks were clothed in a felt shirt under the jerkin, there was only slight difference in the numbers of mosquitoes attracted to each, since the difference in surface temperature of the clothing was no more than 4° F. When the clothing was moistened, the warm robot was nearly twice as attractive as the cool one.

Clothing soaked in water that had been saturated with carbon dioxide gas was found to be no more attractive than normal wet clothing. However, a jerkin which had been employed to dry the sweat from the bodies of two men proved to be almost twice as attractive as a clean jerkin of equal moisture content.

When carbon dioxide was passed through the head orifice at a rate equivalent to normal exhalation in the human, achieved by using a 10 per cent carbon dioxide mixture at 2 litres a minute, the attractiveness of both head and body was raised by 50 per cent. When air alone was passed at the same speed, it was no greater than when nothing was exhaled. When 100 per cent carbon dioxide was employed, the attractiveness of the body was doubled and that of the head was tripled. The vapours of ether and of petrol were found to be significantly attractive when emitted in air by this method, whereas the vapour of chloroform was significantly repellent.

White clothing proved to be much less attractive than black at all light intensities, only one-quarter to one-tenth as many mosquitoes alighting on it. Light shades of red or blue attracted less than half as many mosquitoes as the dark shades. Green was less attractive than red or blue. Blue was slightly less attractive than red when dark shades were compared, whereas light blue was slightly more attractive than pink. Luminescent satins proved to be significantly less attractive than their ordinary counterparts in every case of the six pairs of matched colours studied.

So far as texture was concerned, satins were less attractive than broadcloths or crepes. Clothing of woven nylon was found to be considerably less attractive than cotton shirts and drill trousers.

Full details of these findings are being published elsewhere.

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Sept. 20.

Competition between Skin Follicles in Sheep

In sheep, the density and fineness of the fleece are closely correlated. The denser fleeces are finer and shorter. This leads to the suggestion that the quantity of fibre formed by a follicle is to a large extent governed by the number of follicles which are close to it, and therefore to the concept that adjacent follicles compete with each other for a limited amount of fibre substrate. Evidence in support of this hypothesis can be deduced from several very different aspects of the growth of the fleece.

Several workers have shown that in domesticated breeds of sheep the first follicles to be initiated (the primaries) are arranged in groups of three. The central member is initiated about a week before the laterals, which are at first located very close to the central. Dry[1] has shown that the tips of fibres have varied shapes, and Fraser, Ross and Wright[2] that the central follicle forms a fibre with a sickle-shaped tip curl, whereas the lateral follicles form fibres with regularly curled tips. This difference of shape of the tip can be explained in terms of competition between follicles.

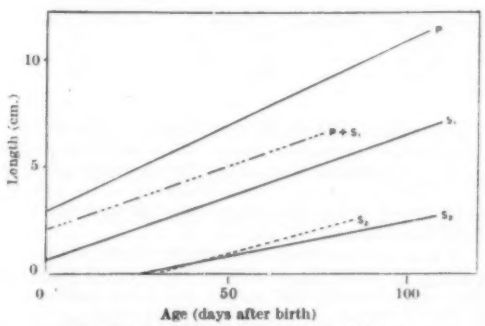
Wool fibres are regularly crimped (waved), and Barker *et al.*[3] have shown that the number of crimps formed along a fibre is a function of time rather than a function of fibre size. Approximately a week is required to form one crimp, that is, to curve a fibre through 180°. Since the rate of curvature is constant, a regular shape of crimp will occur if the fibre growth-rate is constant, whereas if the fibre growth-rate varies during the formation of a crimp, the shape of the crimp

will deviate from regularity. The difference between a regularly curled and a sickle-shaped curl can be explained by the growth-rate being constant during the formation of a regularly curled fibre, but decreasing during the latter part of the formation of the tip curl of a sickle fibre. Such a decrease is inherent in the formation of the trios of primary follicles if these compete with each other for a limited amount of fibre substrate. The central follicle commences its fibre about five days before the laterals, and in that time will have formed about two-thirds of its tip curl. As the lateral follicles commence the formation of their fibres, they will increasingly compete with the central follicle, causing it to decrease in the rate at which it forms the last one-third of its tip curl. On the basis of the concept of competition, the central follicle is expected to form a fibre with a sickle-shaped tip curl.

All fibres which commence their growth before birth have much smaller crimps in the portion formed before birth than in the part formed after birth. This can be explained by the marked increase of body-area which occurs after birth, causing a decrease of follicle density, and therefore a decrease in the intensity of competition.

The adult follicle population consists of three groups of follicles: primaries, first secondaries and second secondaries[4]. Fraser, Ross and Wright[2] have shown that the fibres formed by each of these groups can be recognized from various characters, and it is therefore possible to trace their separate rates of growth. This has been done for the *N*-type and non-*N*-type strains of the Romney breed, which differ monogenically; the effect of the gene being to increase the rate of growth of the primary fibres, which grow faster in *N*-type than in non-*N*-type. Since the gene does not affect either the fleece weight or the follicle population, it follows that if competition occurs then the increase in the rate of growth of the primary fibres must be compensated by a decrease in the rate of growth of the secondary fibres. As shown in the accompanying figure, such a decrease does occur. The decrease per follicle in secondary follicles is smaller than the increase in primaries because the compensation is spread over the more numerous secondary follicles.

A similar case of compensation can be seen in the comparison of the 'carpet' and 'longwool' types of fleece. In the 'carpet' type the primary fibres are much longer than the rest of the fleece, whereas in the 'longwool' type all the fibres are of the same order of length. In sheep fibres, diameter and length are closely correlated, and therefore a comparison of fibre diameters is approximately equivalent to a comparison of fibre lengths. The existence of compensation is suggested from the comparison of frequency distributions of fibre diameters in these two types of fleece. Data shown in the accompanying table are given by Bergen and Mauersberger[5]. In the carpet type some of the fibres have very large diameters, and in compensation others have very fine diameters.



Regression lines of the rate of increase of fibre length in *N*-type (solid lines) and non-*N*-type (broken lines) sheep. The main effect of the gene causing the *N*-type/non-*N*-type difference is to cause the *P* fibres to grow faster. A compensatory decrease can be seen in the comparison of the rate of growth of the S_1 fibres

Fibre Diameter in μ

	-20	20-30	30-40	40-50	50-60	60-70	70-200
'Carpet'	15	35	26	8	6	3	8
'Longwool'	2	18	27	40	10	2	–

Similarly, in wild sheep, the coat, which is clearly divided into two types of fibres, consists of very coarse outer fibres and very fine inner types. The former are coarser than occur in the 'carpet' type of fleece, and the latter are conversely finer.

It appears from this varied range of evidence that the concept of follicles competing for fibre substrate has a reasonable basis.

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Edinburgh. Oct. 6.

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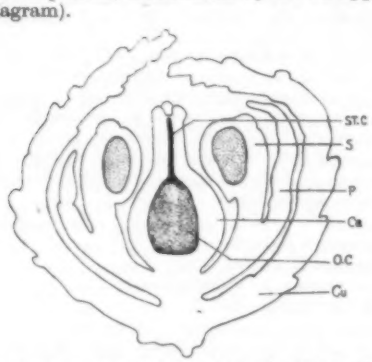
Occurrence of a Hermaphrodite Flower in *Arceuthobium minutissimum* Hook. f., the Smallest Known Dicotyledonous Plant

Arceuthobium minutissimum Hook. f. (Arceuthobieæ), the most minute dicotyledonous plant, is endemic in India, and according to Hooker[1] occurs as a leafless parasite, restricted to a single host-species, *Pinus excelsa* Wall., in the Kumaon Himalayas at an altitude of 10,700 ft., and exhibits perhaps the highest degree of adaptation to a parasitic mode of life known in the family Loranthaceæ. Turrill[2] mentions that the whole plant is 2–5 mm. in length. Prof. S. P. Agharkar collected material of the plant from Nepal and Kashmir for my study of its anatomy, while I was working under him in the Botany Department, University of Calcutta, as a Ghose research scholar.

Hooker[1] writes, with reference to this plant: "Stem none but inconspicuous stock that ramifies within the bark and which the minute branches perforate but scarcely rise above the surface, appearing as a 2-lipped cup, male flower sessile in the cup, 3–5-partite, female flower pedicelled". The aerial shoot system is thus very much reduced and mainly reproductive, while the endophytic vegetative system is well developed and mycelium-like, fuller details of which will be published elsewhere.

On examination of fresh material, it is evident that the flowers are unisexual and greenish in colour, as was reported by Strachey and Winterbottom[3], and since the plants grow within the host barks, ramifying densely, it is almost impossible to state whether it is monœcious or dioœcious, unless and until seeds are allowed to germinate on fresh unaffected *Pinus excelsa* stems separately. That is why Hooker[1] doubted and Danser[4] could not affirm its dioœcious nature.

In the course of my investigations, I came across only one hermaphrodite flower (in microtome sections), which reveals that there are two opposite sepaloid perianth-segments or tepals, as described by Thoday and Johnson[5] in *Arceuthobium pusillum* Peck. In addition, there are two stamens adnate with the bases of the tepals. The anther is single-lobed. The ovary is superior (instead of inferior) and unilocular, and the stigma is trifid. Running from the cavity of the ovary throughout the length of the style is a prominent stylar canal. The complete flower is borne on a short pedicel, surrounded by a two-lipped cup (see diagram).



Section of a hermaphrodite flower of *A. minutissimum* Hook. f. × 425. *Cu*, cup; *O.C.*, Ovarian chamber; *Ca*, carpel; *P*, perianth segment; *S*, stamen; *St.C*, stylar canal

As I found[6] in the case of *Morus indica* Linn. (= *M. alba* Linn.), the occurrence of unisexual flowers in this species is also due to the arrest or reduction of one sex (male or female, as the case may be). These unisexual flowers are not simple and seem to be derived in the course of evolution from bisexual ones, which might have flourished very long ago. Hermaphroditism and hypogyny in this case are thus cases of reversion to their primitive nature.

I wish to offer my thanks to Prof. S. P. Agharkar for his interest and guidance in this work, and to Dr. K. Biswas, superintendent, Indian Botanic Gardens, Sibpur, Calcutta, for library references.

R. M. Datta

Jute Agricultural Research Institute,
Hoogly, West Bengal. Sept. 15.

[1] Hooker, Sir J. D., "Flora of British India", **5**, 227 (1890).
[2] Turrill, W. B., *Kew Bull.*, 264 (1920).
[3] Strachey, Sir R., *et al.*, "Catalogue of Kumaon Plants", 158 (1906)
[4] Danser, B., *Bull. Jard. Buit.*, (iii), **11**, 455 (1930–31).
[5] Thoday, D., and Johnson, E. T., *Ann. Bot.*, **44**, 813 (1930).
[6] Datta, R. M., *Sci. and Cult.*, **4**, 301 (1938); **5**, 373 (1939).

Frequency Differential Thresholds for Quality in Pure Tones

Attempts have been made to determine whether pure tones of equal loudness but different pitch are also different in quality, and whether it is possible to find frequency differential thresholds for the quality differences. Following the usual practice, the terms 'loudness', 'pitch' and 'quality' are used to refer specifically to auditory sensations, while 'intensity' and 'frequency' refer to characteristics of the sound-wave stimulus. In this preliminary work, the experimenter was the subject for the comparisons, which were made monaurally with an earphone.

It was found possible not only to observe quality differences, but also to describe them. The descriptions were always metaphorical and never altogether satisfactory but appeared to be fairly stable, that is, they seemed equally apt even after long periods of practice in listening and long rest periods over the course of several months. The following are typical of the listener's remarks: 500 c.p.s. sounds 'purer, clearer, more bell-like' than 125 c.p.s.; 250 c.p.s. sounds 'somewhat narrower, thinner and not so fuzzy' as 125 c.p.s.; 2,000 c.p.s. sounds 'sharp and hard' when compared with the 'soft, blunt, more comfortable' 125 c.p.s.; 1,500 c.p.s. has a 'reedy' quality not observed in 1,000 c.p.s. It seems relevant to note that few of the metaphors are drawn from volume or density concepts.

Convinced by these and other observations that pure tones may have different qualities, attempts were made to determine the minimum frequency-changes which would be accompanied by changes in quality, that is, to determine the frequency differential thresholds for the quality of pure tones. In the experiment an electronic switching device was used which, on pressing a button, presented the two sinusoidal sounds one after the other for equal time-periods with a short constant intervening silence. It was possible to select the frequency for either of the tones to be compared from throughout the auditory range. By means of separate attenuators and a 40-phon loudness-level chart for the listener's right ear, the loudness of the two tones was kept always equal regardless of frequency differences.

The method was to set the first tone of the comparing device at a base frequency (for example, 125 c.p.s.) with a loudness of 40 phons, and vary the frequency of the second, keeping its loudness constant at 40 phons. Thus 125 c.p.s. was compared with 135 c.p.s., then with 500 c.p.s., then with 200 c.p.s., and so on. For each comparison, a record was made of the frequency of the tones and whether or not a difference of quality was observed. Choice of frequencies for the second tone was more or less random until the general area of the differential threshold became apparent. Then frequencies were selected with the view of narrowing the area.

The accompanying figures are presented only as an indication of the type of finding looked for and as some proof of the plausibility of such research. Figures are averages of several trials, but represent both casual, as well as careful, observations.

Base freq.	*DL* in c.p.s. freq. increase	*DL* in p.c. freq. increase
125	Between 40 and 100	Between 32 and 80
500	150 280	30 56
1000	200 350	20 35
3000	400 1000	13 33
4000	600 1000	15 25

The second column is read thus: compared with 125 c.p.s., frequencies up to 125 + 40 = 165 c.p.s. showed no difference in quality, but frequencies above 125 + 100 = 225 c.p.s. were observed to be different in quality; observations between 165 and 225 c.p.s. were inconsistent.

It is concluded that differential thresholds for the quality of pure tones can be determined and that they will probably fall within the areas indicated.

P. Denes
F. A. Cartier

Department of Phonetics,
University College,
London, W.C.1. Oct. 6.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 5

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. P. Sigon Ham: Presidential Address.

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. W. Aeg. Timmerman: "The Work of the World Health Organization".

Tuesday, February 6

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CENTRE (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. S. W. Broadhurst and Dr. A. W. M. Coombes: "Some Aspects of Electronic Circuit Design".

BRITISH INSTITUTE OF MANAGEMENT (at Management House, 8 Hill Street, London, W.1), at 5.30 p.m.—Mr. H. B. Maynard: "Methods—Time—Measurement".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. F. H. Garner and Mr. S. R. M. Ellis: "Applicability of Vapour–Liquid Equilibria to Extractive Distillation".

ROYAL ANTHROPOLOGICAL INSTITUTE (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. S. Zuckerman, F.R.S.: "*An* Ape or *the* Ape".

INSTITUTION OF WORKS MANAGERS, MERSEYSIDE BRANCH (at the Adelphi Hotel, Liverpool), at 6.30 p.m.—Mr. A. Scholes: "Personnel Problems of a Works Manager".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. Eric G. Moore: "Austria".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, PHYSICAL METHODS GROUP (at the Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Papers on "X-Ray Analysis".

INSTITUTION OF WORKS MANAGERS, LEICESTER BRANCH (at the College of Technology, Leicester), at 7 p.m.—Mr. J. E. Chadbund: "Designing for Standardisation and Production".

SHEFFIELD METALLURGICAL ASSOCIATION (at the Grand Hotel, Sheffield), at 7 p.m.—Mr. L. Rotherham: "Titanium".

Wednesday, February 7

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London W.C.2), at 2.30 p.m.—Dr. Stanley Gooding: "Recent Research on Bees and Beekeeping".

INSTITUTE OF RURAL LIFE AT HOME AND OVERSEAS (in Room 013, Sanctuary Buildings, Great Smith Street, London, S.W.1), at 5.30 p.m.—Major Jasper Wyld: "Background to the Development of a Central African Tribe".*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. Brewer: "Radio-Valve Life Testing".

UNIVERSITY OF LONDON (at the School of Pharmacy, 17 Bloomsbury Square, London, W.C.1), at 5.30 p.m.—Dr. Lester Smith: "The Isolation, Properties and Functions of the Vitamins B_{12}".* (Further Lecture on February 8.)

INSTITUTE OF WELDING, MANCHESTER AND DISTRICT BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. W. A. Woolcott: "Argon Arc Welding".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, February 8

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. E. J. Burge and Mr. L. C. Jackson: "The Thickness of the Helium Film".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. W. Jones: "The Spawning Behaviour of the Atlantic Salmon".

ROYAL SOCIETY OF ARTS, INDIA, PAKISTAN AND BURMA SECTION (joint meeting with EAST INDIA ASSOCIATION, at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. S. J. Wright: "Some Agricultural Problems of Pakistan".

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (joint meeting with the ROYAL PHOTOGRAPHIC SOCIETY and the MANCHESTER AMATEUR PHOTOGRAPHIC SOCIETY, in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. Laurence H. A. Carr: "The Scientific Relationship between Illumination and Photography".

ROYAL STATISTICAL SOCIETY, LONDON GROUP of the INDUSTRIAL APPLICATIONS SECTION (joint meeting with the STUDY SECTION, at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Symposium on "Factor Analysis".

INSTITUTE OF METALS, LONDON SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 7 p.m.—Mr. E. W. Colbeck: "The Metallurgy of Uranium".

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. R. F. Bowles: "The 'Empirical Flow Test' and Quality Control of Printing Inks".

WOOL EDUCATION SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7 p.m.—Mr. E. G. Carter: "The Scientist Looks at Wool".

INSTITUTION OF WORKS MANAGERS, TEES-SIDE BRANCH (at the Vane Arms Hotel, Stockton), at 7.30 p.m.—Mr. E. F. L. Brech: "Some Aspects of Operator Training".

TEXTILE INSTITUTE, SCOTTISH SECTION (at the Scottish Woollen Technical College, Galashiels), at 7.30 p.m.—Dr. P. W. Cunliffe: "Package Dyeing".

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (at the Midland Hotel, Manchester), at 7.45 p.m.—Mr. F. W. Adams: "The Ethics of Pharmacy".

Friday, February 9

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 2.15 p.m.—Annual General Meeting.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting, followed by Annual General Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the HYDRAULICS GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. J. S. Blair: "New Formulæ for Water Flow in Pipes"; Mr. L. E. Prosser, Mr. R. C. Worster and Mr. S. T. Bonnington: "Friction Losses in Turbulent Pipe-flow".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (joint meeting with the INSTITUTION OF CIVIL ENGINEERS, the INSTITUTION OF MECHANICAL ENGINEERS, and the ROYAL AERONAUTICAL SOCIETY, at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Teaching Mechanics to Engineers".

SOCIETY OF GLASS TECHNOLOGY, NORTH-WEST SECTION (at the Gas Showrooms, Radiant House, St. Helen's), at 6 p.m.—Mr. S. T. Pickering: "Time and Motion Study as an Aid to Management in the Glass Industry".

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "The Chemistry of Stand Oil Formation—some Facts and Fancies".

TEXTILE INSTITUTE, SCOTTISH SECTION (at the School of Economics, Bell Street, Dundee), at 7.30 p.m.—Mr. A. S. Gillies: "Practical Research within the Jute Mill".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BACTERIOLOGIST (Principal Scientific Officer grade)—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks (February 10).

CHIEF SCIENTIST (with a good honours degree in science or equivalent qualification)—The Establishments Officer, Durham Division, National Coal Board, 'D' Floor, Milburn House, Newcastle-upon-Tyne 1 (February 12).

PRINCIPAL OF THE GOLD COAST COLLEGE OF ARTS, SCIENCE AND TECHNOLOGY, KUMASI—The Secretary, Advisory Committee on Colonial Colleges of Arts, Science and Technology, 15 Victoria Street, LONDON, S.W.1 (February 15).

READERSHIP IN ZOOLOGY at King's College of Household and Social Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 16).

CHAIR OF PATHOLOGY, a SENIOR LECTURER IN PATHOLOGY, and a SENIOR LECTURER IN BACTERIOLOGY, at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 17).

SENIOR EXPERIMENTAL OFFICERS and EXPERIMENTAL OFFICERS in the Mechanical Engineering Research Organization (Department of Scientific and Industrial Research), for the design of precision measuring equipment used in engineering metrology and the design and lay-out of test rigs for basic research on the performance of all types of mechanism—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.23/51A (February 19).

ASSISTANT COMMISSIONER to assist in the selection of engineering and technical personnel for permanent appointments in the Civil Service—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1 (February 22).

TECHNICAL ASSISTANT (male) to the Head of Establishment at the Air Ministry Survey Production Centre at Teddington (with University degree in engineering or science or equivalent qualifications, and knowledge of and practical experience in geodesy applied to mapping and aerial navigation, map construction and cartography, process photography, lithographic reproduction)—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3478 (February 22).

CHIEF MEDICAL STATISTICIAN in the General Register Office—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 3471 (February 23).

BIOLOGIST for work in the statistics section on problems of tree variation and measurement—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (February 24).

LECTURER IN CHILD HEALTH—The Secretary, The University, Aberdeen (February 24).

PHYSICISTS (Experimental or Assistant Experimental Officer grade) in a Ministry of Supply research establishment near London, for experimental work with radioactive materials, including radiation measurements for health physics, also instrument construction, calibration and maintenance—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.28/51A (February 24).

PHYSICISTS (Senior Scientific Officer or Scientific Officer grade) in a Ministry of Supply research establishment near London, for the handling and measurement of radioactive materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.27/51A (February 24).

Assistant Lecturer (with an honours, special or higher degree in zoology), in the Department of Zoology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (February 26).

Scientist, Grade I (with a good honours degree or equivalent qualification, and with research experience in physics or engineering) at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/293 (February 26).

Chemical Hydrographer (Assistant Lecturer) at the Marine Biological Station, Port Erin, Isle of Man—The Registrar, The University, Liverpool (February 28).

Professor of Greek and Roman Archæology at Farouk I University, Alexandria—The Director-General, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (February 28).

Professor of Human Geography at Farouk I University, Alexandria—The Director-General, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (February 28).

Chief Scientific Officer (with a first- or second-class honours degree in science or engineering, or equivalent qualifications, and extensive experience of research and development on radar, communications and electronics) in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3480 (March 1).

Milk Products Graders and Inspectors (with degree or diploma in dairying and commercial experience of the manufacturing and marketing of milk products) in the Ministry of Food—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.9/51A (March 1).

Principal—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (March 5).

Post-Graduate Studentships for research in the Colonial territories in (*a*) Fisheries, (*b*) Soil Science, (*c*) Agriculture, (*d*) Veterinary Science—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1 (March 15).

I.C.I. Research Fellowship (preferably in the fields of nuclear physics or radiochemistry)—The Secretary, The University, Birmingham 3 (April 1).

Senior Scientific Officer (Ref. F.32/51A) for the chemical analysis of rocks and minerals for scientific and industrial purposes, and the laboratory investigations of clays, etc., in order to ascertain whether they have possible economic uses, a Scientific Officer (Ref. F.33/51A) for the chemical and spectroscopic analysis of rocks and minerals and the laboratory testing of mineral raw materials, and an Assistant Experimental Officer (Ref. F.34/51A) to assist in the above duties, in the Chemical Laboratories of the Mineral Resources Division of the Directorate of Colonial Geological Surveys—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (April 14).

Assistant Experimental Officers for posts in various Government departments and divided between (*a*) Mathematical and Physical Sciences, (*b*) Chemistry and Metallurgy, (*c*) Engineering Subjects, and (*d*) Miscellaneous, including, for example, geology, library and technical information services—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068 (July 31).

Aeronautical and Mechanical Engineers (Experimental Officer grade) at Ministry of Supply research and development establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.679/50A.

Assistant (with Higher School Certificate, preferably with Biology as a principal subject, or an equivalent qualification) to the Officer-in-Charge of the Falkland Islands Dependencies Scientific Bureau, Westminster, London, S.W.1—The Under-Secretary of State (Research Department), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Chemists (Experimental Officer grade) in Ministry of Supply research and development establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.704/50A.

Chemists and Chemical Engineers (Scientific Officer grade) in Ministry of Supply experimental establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.726/50A.

Civil Engineer in the Public Works Department, Hong Kong—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/92.

Electrical Engineer (Meters and Protection) by the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.25727.B.

Lecturer in the Chemistry Department, to teach Inorganic chemistry to Higher National Certificate standard, Widnes Municipal Technical College—Mr. W. R. Wainwright, Education Office, Lugsdale Road, Widnes.

Organic Chemist (preferably with some research experience)—The Director, Research Association of British Flour Millers, Cereals Research Station, Old London Road, St. Albans, Herts.

Physical Chemist (with first- or second-class honours degree and research experience) to supervise work on the physics and chemistry of surfaces, detergency of raw wool, and mechanical processing—The Secretary, Wool Industries Research Association, Torridon, Headingley, Leeds 6.

Scientific Assistant (male or female, with a sound knowledge of chemistry to School Certificate standard)—The Secretary, Room 163, New Scotland Yard, London, S.W.1.

Scientific Officer to join a team studying plankton ecology in relation to the fisheries—The Officer in-Charge, Oceanographic Laboratory, 23 Sandport Street, Leith, Edinburgh.

Scientific Officer to undertake work on microbiology—The Director, Marine Station, Millport, Isle of Cumbrae.

University Graduate in Science (preferably with post-graduate training and 2–5 years experience in hydrodynamics or aerodynamics, and ability to apply theoretical principles to research and development problems) at the Canadian Naval Research Establishment, Halifax, Nova Scotia—The Defence Research Member, Canadian Joint Staff, 11 Hill Street, London, W.1.

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

A Survey of Thesis Literature in British Libraries. By P. D. Record. Pp. 21. (London: Library Association, 1950.) 2*s.* 6*d.*; 2*s.* to members. [1210

Scottish Home Department. Scientific Investigations, Freshwater and Salmon Fisheries Research, No. 1: Report by the Supervisory Committee for Brown Trout Research, 1948–49. Pp. 12. (Edinburgh and London: H.M. Stationery Office, 1950.) 1*s.* net. [1210

National University of Ireland. Calendar for the Year 1949. Pp. x+282+860. (Dublin: National University of Ireland, 1949.) [1210

British Standard 240, Part 2: 1950, Steel Balls for Brinel Hardness Testing. Pp. 8. 2*s.* net. British Standard 1669: 1950, Industrial Perforated Plates. Pp. 10. 2*s.* net. (London: British Standards Institution, 1950.) [1210

Air Ministry: Meteorological Office. Meteorological Reports No. 6: Equivalent Headwinds; Application of Upper-wind Statistics to Air-Route Planning. Compiled by J. S. Sawyer. Pp. ii+20. (London: H.M. Stationery Office, 1950.) 9*d.* net. [1210

Annals of the Cape Observatory. Vol. 14, Part 4: Results of Meridian Observations of the Sun, Mercury and Venus made at the Royal Observatory, Cape of Good Hope, in the Years 1925 to 1936. Prepared for press under the direction of Dr. J. Jackson. Pp. xiv+103. (London: H.M. Stationery Office, 1950.) 15*s.* net. [1210

Institute of Navigation. Report of the Council for 1949–50. Pp. 12. (London: Institute of Navigation, 1950.) [1610

Oryx: Journal of the Fauna Preservation Society. Vol. 1, No. 1, October. Pp. 64. (London: Fauna Preservation Society, 1950.) 2*s.* 6*d.*; 20*s.* per year. [1610

Department of Scientific and Industrial Research. Report for the Year 1948–49. (Cmd. 8045.) Pp. 260. (London: H.M. Stationery Office, 1950.) 5*s.* 6*d.* net. [1610

The West Indies and the Mountain Uplift Problem. Part 2: Additional Observations, 1948. By Dr. C. T. Trechmann. Pp. 31+7 plates. New Zealand and my Forbidden Theory of Mountain Uplift. Part 3 of the West Indies and the Mountain Uplift Problem. By Dr. C. T. Trechmann. Pp. 35+7 plates. (Castle Eden, Co. Durham: The Author, 1948–1950.) [1616

Other Countries

Indian Forest Bulletin No. 143 (Cellulose and Paper, New Series): Interim Report on the Manufacture of Newsprint from Paper Mulberry (*Broussonetia papyrifera*). By Chattar Singh. Pp. 14+2 plates. (Dehra Dun: Forest Research Institute, 1950.) 1 rupee; 1*s.* 6*d.* [1210

Indian Forest Records, New Series. Entomology, Vol. 7, No. 7: A List of Described Immature Stages of Indian Lepidoptera. Part 1, Rhopalocera. Compiled by G. D. Pant and M. C. Chatterjee. Pp. 213–256. 1.8 rupees; 2*s.* 3*d.* Entomology, Vol. 8, No. 1: The Puparia of some Indian Tachinidæ (Diptera), 3. By Dr. R. N. Mathur. Pp. 6+1 plate. 10 annas; 1*s.* (Dehra Dun: Indian Forest Institute, 1950.) [1210

Southern Rhodesia. Geological Survey Bulletin No. 39: The Geology of the Country around Gwelo. By R. Tyndale-Biscoe. Pp. viii+145. (Salisbury: Government Stationery Office, 1949.) 6*s.* 6*d.* [1610

Smithsonian Institution: Freer Gallery of Art. Occasional Papers, Vol. 1, No. 3: Studies in Muslim Iconography, 1, The Unicorn. By Richard Ettinghausen. (Publication 3993.) Pp. xii+209+48 plates. (Washington, D.C.: Smithsonian Institution, 1950.) [1610

United States Department of Agriculture. Circular No. 850: White-fringed Beetles and How to Combat Them. By H. C. Young, B. A. App, J. B. Gill and H. S. Hollingsworth. Pp. 15. (Washington, D.C.: Government Printing Office, 1950.) [1610

State of California: Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 76: Average Lunar Month Catch by California Sardine Fishermen 1932–33 through 1948–49. By Frances N. Clark and Anita E. Dougherty. Pp. 28. Fish Bulletin No. 77: A Comparison of the Bluefin Tunas, Genus Thunnus, from New England, Australia and California. By H. C. Godsil and Edwin K. Holmberg. Pp. 55. (Terminal Island, Calif.: State Fisheries Laboratory, 1950.) [1610

United States Department of Commerce: National Bureau of Standards. Circular 499: Nuclear Data; a Collection of Experimental Values of Half-lives, Radiation Energies, Relative Isotopic Abundances, Nuclear Moments and Cross Sections. Compiled by Katharine Way, Lilla Fano, Millicent R. Scott and Karin Thew. Pp. xiv+309. (Washington, D.C.: Government Printing Office, 1950.) 4.25 dollars. [1610

Annals of the New York Academy of Sciences. Vol. 50, Art. 10: Medical Mycology. By Frederick Reiss and 15 other Authors. Pp. 1209–1404. 2.75 dollars. Vol. 53, Art. 2: Terrmycin. By C. S. Keefer, J. H. Kane and 83 other Authors. Pp. 221–460. 3 dollars. (New York: New York Academy of Sciences, 1950.) [1610

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GRANTS & SCHOLARSHIPS

COLONIAL RESEARCH STUDENTSHIPS

The Secretary of State for the Colonies proposes to offer in 1951 a limited number of post-graduate Studentships, tenable at a British university or research institute or organization, either in the United Kingdom or overseas, for periods of up to two years, in preparation for research in the Colonial territories in (a) Fisheries, (b) Soil Science, (c) Agriculture, (d) Veterinary Science. It would be a condition of the award that the student undertakes, if so required, to carry out specified research in any territories named by the Secretary of State for not less than two to three years after the completion of training. During the tenure of the Studentship a maintenance allowance is payable at the rate of £300 per annum (£360 per annum if training is at Oxford, Cambridge or London), with the addition for a married student of £110 per annum marriage allowance, plus children's allowances. These allowances are all tax free. Provision is made separately for the payment of fees. Candidates, who should be under 32 years of age, should hold a first- or a good second-class honours degree in (a) For Fisheries Research Studentships: biology, biochemistry or physiology. (b) For Soil Science Research Studentships: chemistry, physics, geology, microbiology, biology or botany. (c) For Agricultural Research Studentships: such subjects as biochemistry, cytogenetics, plant physiology, virology or agricultural statistics. (d) For Veterinary Research Studentships: a veterinary qualification registrable with the Royal College of Veterinary Surgeons. Candidates taking degrees this summer may apply before the result of the degree examination is known.

Application forms are obtainable from the Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1. Completed applications should reach the Colonial Office not later than March 15, 1951.

SCHOLARSHIPS ABROAD, 1951–52

Applications are invited from British students for scholarships offered by governments and universities in the following countries: Austria, Belgium, Brazil, Denmark, Finland, France, Germany, Italy, The Netherlands, Norway, Persia, Portugal, Spain, Sweden and Switzerland. These scholarships are tenable during the academic year 1951-52, usually for the complete session, but in some cases for shorter periods. Closing dates for applications from candidates vary for each country, the earliest date being March 7, 1951.

Full particulars and application forms are obtainable from any British Council office in the United Kingdom, or by post, on receipt of a stamped addressed foolscap envelope, from the British Council, 65 Davies Street, London, W.1.

UNIVERSITY OF MANCHESTER
I.C.I. FELLOWSHIPS

Applications are invited for the above research fellowships, founded by Imperial Chemical Industries, Ltd., tenable in the university and available for research in chemistry, physics, and allied subjects. The value of the fellowships will be within the range of £600 to £900 per annum, according to qualifications and experience.

Regulations governing the award of the Fellowships may be obtained from the Registrar, the University, Manchester, 13, to whom all applications should be sent not later than April 30, 1951.

UNIVERSITY OF MANCHESTER
TURNER AND NEWALL RESEARCH FELLOWSHIP

Applications are invited for the above research fellowship, normally of the value of £600 per annum, founded by Turner and Newall, Ltd., tenable in the university and available for research in engineering, inorganic chemistry, physics, and allied subjects.

Regulations governing the award of the Fellowship may be obtained from the Registrar, the University, Manchester, 13, to whom all applications should be sent not later than April 30, 1951

POSTGRADUATE SCHOLARSHIPS IN TEXTILES

The British Rayon Research Association invites applications from university students who expect to graduate this year for scholarships in textile technology, textile engineering, textile chemistry, or dyeing. The scholarships are normally of the value of £300 a year, plus fees, but in special circumstances an increased allowance may be paid. Scholarships are tenable at Leeds, Manchester or other universities or technical colleges where there are appropriate facilities, for a period of two years, though this may be extended in suitable cases by a year of study overseas.

For further particulars and application forms write to the Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

UNIVERSITY OF CAMBRIDGE
I.C.I. FELLOWSHIPS

Applications are invited for Research Fellowships, value within the range £600 to £900 a year, founded by Imperial Chemical Industries, Ltd., tenable in the University and available for research in Physics, Chemistry, Biochemistry, Engineering, Metallurgy, Pharmacology, Chemotherapy, or related subjects.—Applications must be received not later than April 30, 1951. Regulations governing the award of the Fellowships may be obtained from the Secretary of the Board of Research Studies, the Old Schools, Cambridge, to whom all applications should be addressed.

TRINITY COLLEGE
CAMBRIDGE
PERROTT STUDENTSHIP IN PSYCHICAL RESEARCH

The Electors to the Perrott Studentship are prepared to receive applications from candidates.

Psychical Research is defined, for the purpose of the Studentship, as 'the investigation of mental or physical phenomena which seem prima facie to suggest (a) the existence of supernormal powers of cognition or action in human beings in their present life, or (b) the persistence of the human mind after bodily death.' The Studentship is open to any person who shall have completed his or her twenty-first year at the time when the election takes place. A student may be re-elected once, but not more than once. The Studentship is tenable for one year, and the student will be required to devote a substantial part of the period of his tenure to investigating, in consultation with a supervisor to be appointed by the electors, some problem in psychical research. The student shall not, during his tenure of the studentship, engage in any other occupation to such an extent as would, in the opinion of the electors, interfere with his course of research. Residence in Cambridge is not required. The Studentship will be of such value, not exceeding £300, as the electors may award after considering the nature of the research which the candidate proposes to undertake.

Applications from candidates should be sent to the Secretary, Perrott Studentship Electors, Trinity College, Cambridge, not later than April 30, 1951. Intending candidates should write to the Secretary for further details before applying. The election to the Studentship will take place in the Easter Term of 1951, and, if a candidate be elected, his tenure will begin at Michaelmas following the election.

EMSLIE HORNIMAN ANTHROPOLOGICAL SCHOLARSHIP FUND
SCHOLARSHIPS

The Trustees invite applications from British subjects for Emslie Horniman Anthropological Studentships. The Studentships are open to university graduates and to others able to show that they are likely to profit by the study of anthropology; they will normally be tenable for a maximum period of two years at any recognized university and may include a period of field work. The Studentship Grants will be determined according to the course of study pursued and the circumstances of each case. Cost of living, university dues, travelling and field-work expenses will be taken into consideration.

Applications must be received not later than April 1, 1951. Full particulars may be obtained from the Secretary to the Trustees, Emslie Horniman Anthropological Scholarship Fund, Royal Anthropological Institute, 21, Bedford Square, W.C.1.

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